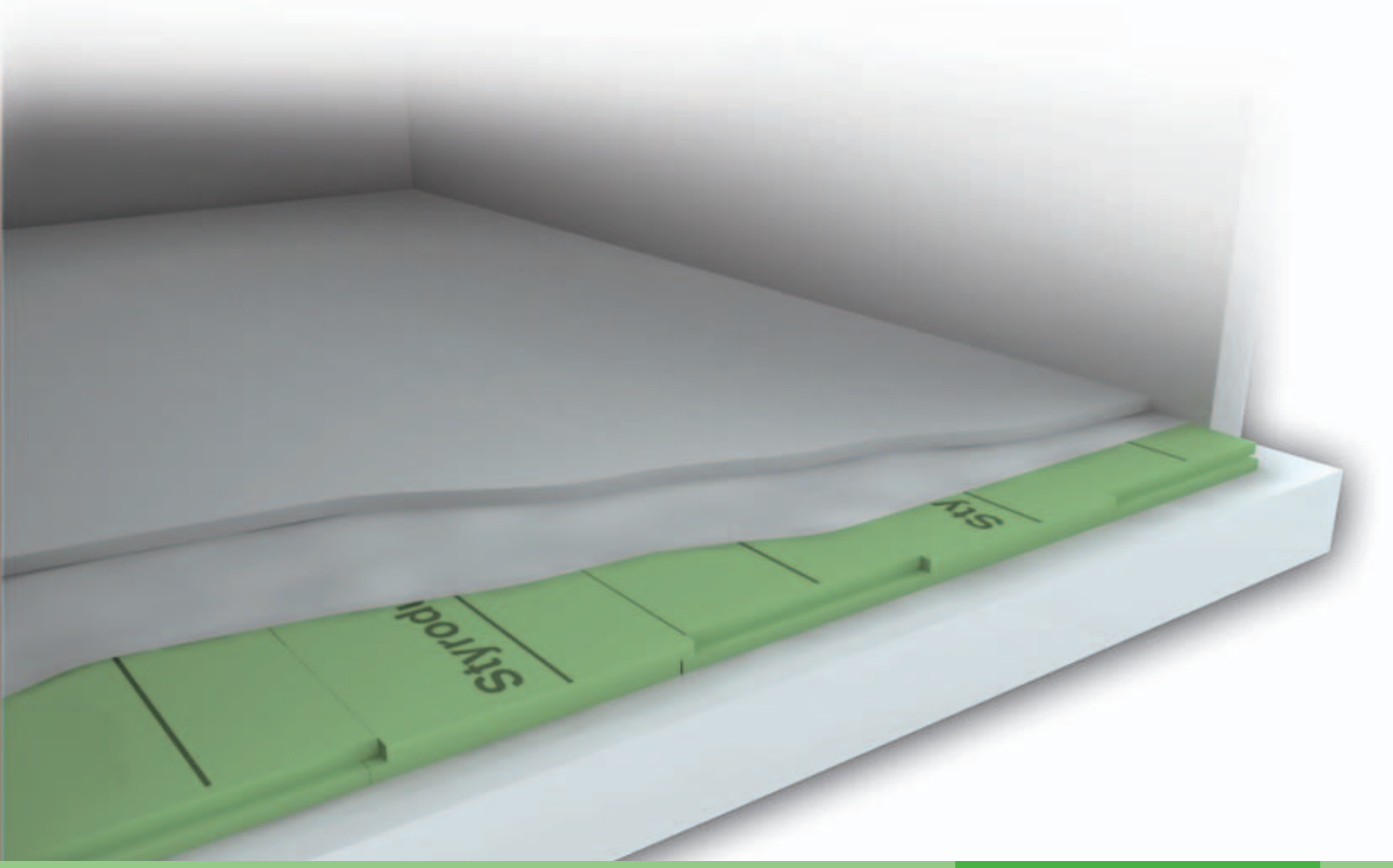
Styrodur® C
Europe's green insulation

Load-bearing and Floor Insulation



BASF
The Chemical Company

Contents Overview

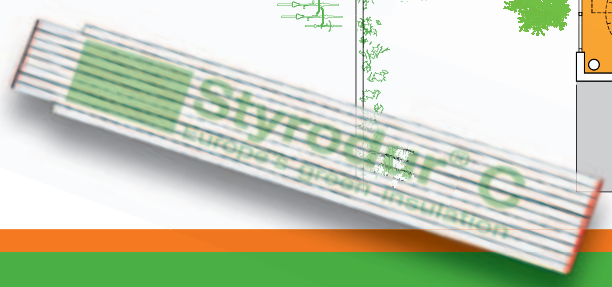
1. Styrodur® C Thermal Insulation

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. Advantages of Styrodur® C

Styrodur® C is used to reduce heat loss, to increase your comfort of living, and to protect buildings from damage. It is often subject to heavy loads, among other stress factors.

Examples for such heavy loads are:
- Earth thrust
- Structural loads (furniture, superstructural parts, merchandise)
- Dynamic loads (vehicles, e. g., for transport)
- Greening and patio surfaces

For many applications, compressive strength is the crucial factor in determining the right insulation. For construction purposes, it is also important that the insulation is not subject to brittle fracture when used on uneven or inhomogeneous ground. Despite its high compressive load, Styrodur C is elastic to the extend of adjusting to any unevenness and responds to local peak loads with plastic deformations rather than with material damage.

If the load, the type of load, as well as the extension and duration of the load effect are known, the existing compressive stress on the insulation board can be calculated. Various types of Styrodur C are available for different loads.

To choose the right type of insulation, it is important to know whether the load is short-term or permanent. The existing compressive stress must not exceed the maximum stress permissible for the insulation material. For more than 40 years, Styrodur C has proved to be valuable with regard to load-bearing insulation.

Fig.1: The parking roof—a load-bearing application of Styrodur® C.

3. Load-bearing Applications

Why heat insulation is needed

Floors protect living, working, and common areas against surrounding air, colder rooms, or directly against the ground. In a single-family house, the heat loss of the floors above the basement or the ground represent up to 20% of the total heat loss of the house.

Minimum heat insulation

DIN 4108-2 determines the minimum insulation values for living areas that are heated to the average indoor temperature (≥ 19 °C).

The purpose of regulating minimum heat insulation is to protect residents from health problems caused by low temperatures of the perimeter walls and against structural damages caused by condensation.

Energy Saving Ordinance (EnEV)

The Energy Saving Ordinance is a basic element of today's climate protection policy. In requiring the consideration of heat insulation when calculating the annual demand for thermal heat and the annual demand for primary energy, the EnEV enables the economic combination of constructional heat insulation and installation engineering.

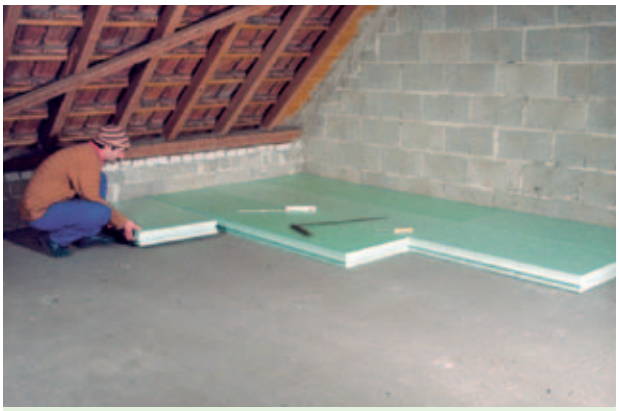


Fig. 2: Attic insulation with Styrodur C.

4. Applications

4.1 Styrodur® C Underneath Foundation Slabs

Styrodur® C meets every requirement for heat insulation in basements. It provides high compressive strength, resistance to decay, and low moisture absorption. In addition, it has been the state-of-the-art building insulation for many years now.

Styrodur C can also be used as thermal insulation in combination with foundation slabs **(Fig. 3)**.

Fig. 3: Insulation of a foundation slab with Styrodur® C.

In more and more houses and office buildings, foundation slabs made of reinforced concrete are being used. In order to avoid thermal bridges, it is recommended to lay Styrodur C underneath the foundation slabs and directly attach the perimeter insulation of the basement wall.

LohrElement E. Schneider GmbH from Gemünden, Germany, offers prefabricated elements of Styrodur C for the production of round formwork for foundation slabs and anti-frost-heave constructions. In this case, the thermal insulation is extended into the ground beyond the foundation slab to prevent frost heaves underneath the foundation **(Fig. 5)**.

Fig. 4: Laying of Styrodur C boards.

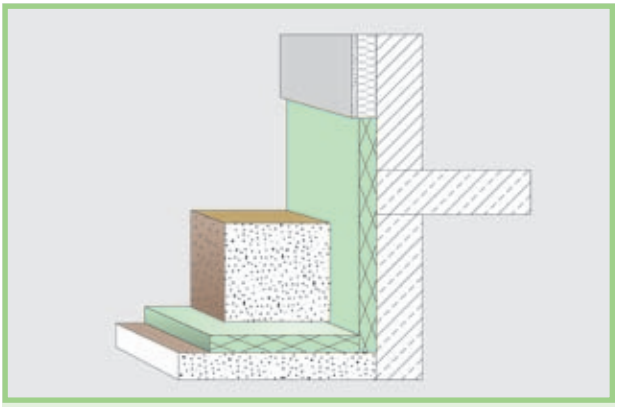


Fig. 5: The anti-frost-heave layer is added in the ground, below the frost line.

4.2 Load-bearing Applications for Roofs

Styrodur C is used for the following applications:

- Roof terraces
- Green roofs
- Parking roofs

In order to increase the housing quality of a building, many flat roofs are being converted into roof terraces. On inverted flat roofs, Styrodur C can protect the roof sealing against mechanical damages and high thermal strain. It can handle heavy loads with ease due to its high compressive strength.

Styrodur C is also suitable for point loads such as from stilted pavement slabs, distributed loads such as from storing slabs in coarse gravel, or for the conversion into a roof garden.

Fig. 6: Vegetated, accessible roof terrace with irrigation system of ponds on an inverted roof construction with full gravel drainage course.

Due to the increase of inner-city traffic, parking becomes scarce. Therefore, many roofs of public buildings and large department stores are converted into parking roofs. To compensate for any heat loss of the heated top levels against the surrounding air, the roof is insulated with Styrodur® C in line with the inverted roof concept **(Fig. 7)**. The high compressive strength of Styrodur C guarantees limitless stability under the load of parked or driving vehicles.

Fig. 7: Parking roof with concrete slab pavement on inverted roof with Styrodur® C.

4.3 Styrodur® C in Road Construction

Applications in road construction:
- Track beds
- Road beds
- Airports

If the ground is exposed to frost heave, its elevation and settlement may cause uncontrolled deformation of the tracks. In such cases, Styrodur C can avoid the penetration of frost into the material and thus the formation of ice lenses within the substructure **(Fig. 8)**.

The subgrade protection layer can be significantly reduced when using Styrodur C. Heavy dynamic loads caused by rail traffic constitute the utmost quality demands placed on Styrodur C.

Fig. 8: Frost protection for track beds with Styrodur C featuring high compressive strength.

Applied in road beds, Styrodur C prevents the penetration of frost into the ground, thereby avoiding frost heaves as well as deformations of the road. In addition, it reduces the required depth for the road bed, which in turn lowers construction and maintenance costs.

Styrodur C demonstrates its outstanding properties even under heavy loads: extremely heavy loads are induced on the ground insulated with Styrodur C via the props of a tripod construction.

Fig. 9: Laying of Styrodur C into the track bed.

4.4 Styrodur® C in Ceilings Beneath Unheated Attics

A lot of energy is saved if the upper side of the building's top floor above the living areas is insulated. Styrodur® C boards may be covered with running boards, hardboards, or floor pavement, depending on intended use of the room.

In order to achieve a thermal transmission coefficient of approx. 0.22 W/(m²·K), the insulation layer has to be approx. 14 cm thick.

Since the attic and chimneys therein are no longer "heated" as a result, it is important to verify whether there exists a possible danger of condensation caused by the fumes in the chimney.

Fig. 10: Insulation of an attic with Styrodur® C.

4.5 Styrodur C in Floors

Styrodur C is also used for:

- Perimeter insulation
- Industrial construction
- Warehouses
- Cold-storage warehouses
- Ice rinks
- Airplane hangars

Depending on their use, floors are subject to different kinds of heavy loads. Warehouses, for example, are subject to compressive stress caused by heavy storage goods or heavy vehicles such as forklift trucks. In cold-storage warehouses, a consistent low temperature has to be maintained at all times. With Styrodur C, you can achieve just that **(Figs. 12, 14, 16, and 17)**.

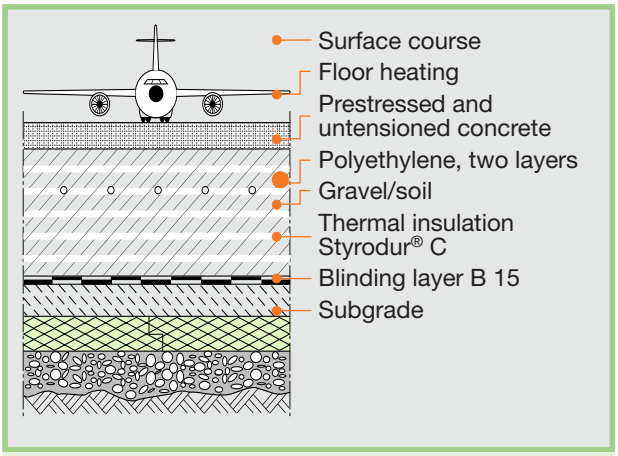


Fig. 11: Insulation of an airplane hangar with Styrodur C.

Fig. 12: Floor of an airplane hangar with floor heating on top of Styrodur C.

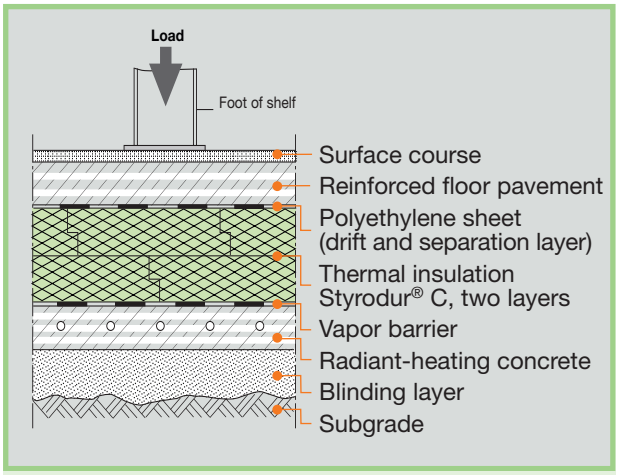


Fig. 13: Thermal insulation with Styrodur® C in floor of cold-storage warehouse.

Fig. 14: Forklift truck and heavy storage goods strain the heat-insulated floor of the cold-storage warehouse.

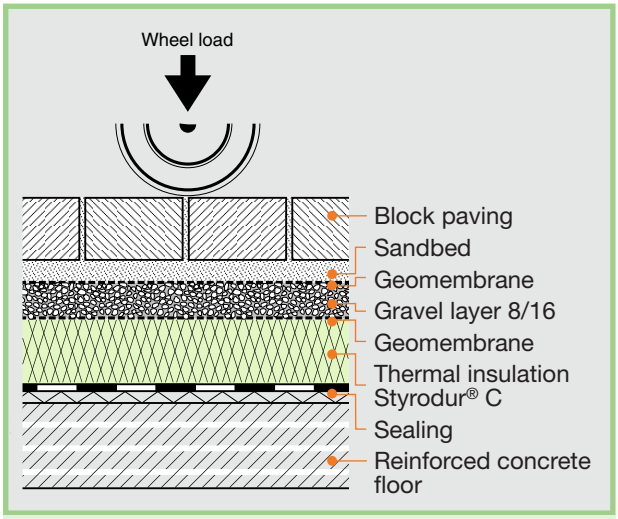


Fig. 15: Wheel load on floor insulation with Styrodur C.

Fig. 16: Styrodur C under ice rink.

Fig. 17: Reference: The Steel Arena in Košice (Slovakia). Home of the 2011 Ice Hockey World Championship. The new hockey arena is insulated with Styrodur C.

4.6 Styrodur® C in Floors Above Unheated Basements Without Subsonic Noise Protection

For floors above unheated basements we suggest a thermal transmission coefficient of ≤ 0.35 W/(m²·K). This can be achieved with, for instance, a 16 mm-thick reinforced concrete floor slab with 50 mm of floor pavement and an insulation of 10 cm Styrodur® C.

The Styrodur C boards are slotted on even ground **(Fig. 19)**, covered with polyethylene, and topped with floor pavement.

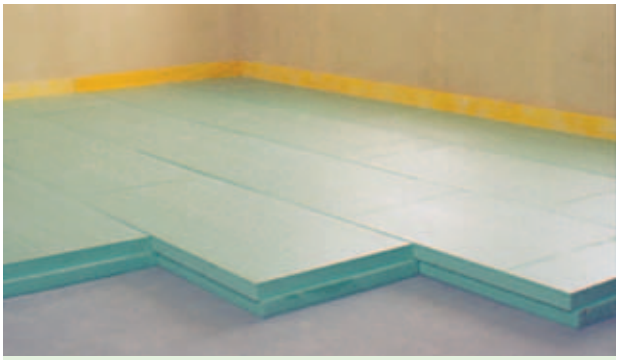


Fig. 18: Floor insulation with Styrodur C.

4.7 Styrodur® C in Floors With Subsonic Noise Protection and Floor Heating Above Unheated Basements

For floor heating we suggest a thermal transmission coefficient of ≤ 0.35 W/(m²·K) for construction components between the heated floor and the unheated basement. Should a subsonic noise insulation be necessary, we recommend the combination of soft subsonic noise insulation boards and hard Styrodur® C boards. You need 8 cm of Styrodur C for a 35/30 subsonic protection board **(Fig. 20)**.

The subsonic noise insulation board adjusts to the unevenness of the slab, and together with the edge trim guarantees the subsonic noise insulation. The hard Styrodur C boards provide the necessary additional thermal insulation while at the same time providing a good surface for the pipes of the hydronic floor heating **(Fig. 21)**.

Fig. 19: Insulation of basement floor.

Fig. 20: Floor insulation with subsonic noise protection in living areas.

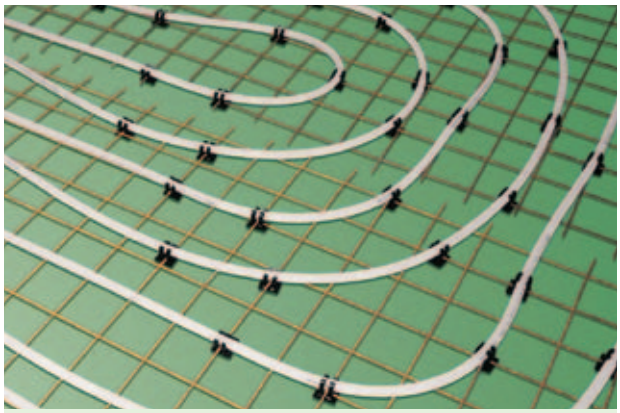


Fig. 21: Thermal insulation with floor heating.

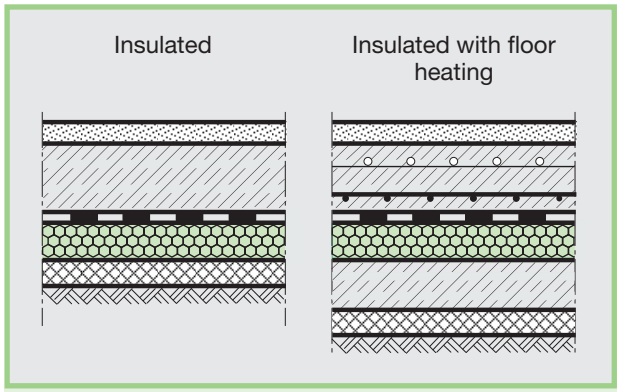


Fig. 22: Floor construction with Styrodur® C.

4.8 Styrodur C Insulation Above the Ground With Floor Heating

For this application we also recommend a thermal transmission coefficient of ≤ 0.35 W/(m²·K) for construction components between the heated floor and the ground. We suggest the use of approx. 12 cm of Styrodur C.

4.9 Styrodur® C for Top-side Insulation of Floor Slabs in Industrial Construction

The top-side insulation of floor slabs is especially advisable for subsequent thermal insulation of existing industrial floors and the installation of a floor heating system **(Fig. 23)**.

The Styrodur® C boards are conjoined on top of the floor slab and covered with polyethylene. A concrete slab is added on top in order to balance the load of forklift trucks or the feet of shelves, for instance.

Fig. 23: Insulation of industrial floor with Styrodur® C.

5. 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

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