Composite panel solutions with STYROFOAM

August 2006
Table of Contents

1. Composite panels with a core of STYROFOAM™ ........................................... 03
   1.1 About STYROFOAM ........................................... 03
   1.1.1 STYROFOAM – from the inventor of XPS .............................. 03
   1.1.2 Product properties .......................................... 03
   1.1.3 Environmental compatibility and durability ......................... 04
   1.2 Long-term experience of STYROFOAM as a core material tried-and-tested in practice ............................................................. 04
   1.3 Applications ...................................................... 04
2. Production and structure of composite panels with STYROFOAM .......................... 05
   2.1 Wide choice of facings ........................................... 05
   2.2 Adhesives ......................................................... 06
   2.3 STYROFOAM core material ....................................... 06
   2.4 Design notes ...................................................... 07
   2.5 Composite panel calculations .................................. 08
3. Composite panels for refrigerated trucks ........................................... 09
4. Composite panels for the construction of camper vans, caravans and portable cabins ...... 10
5. Composite panels for cladding, windows and doors ......................................... 11
6. Technical data ......................................................... 12
7. Notes ................................................................. 14
8. Table of images ....................................................... 14
1. Composite panels with a core of STYROFOAM

1.1 About STYROFOAM™

1.1.1 STYROFOAM – from the inventor of XPS

Extruded polystyrene foam (XPS) was first developed and produced in the 1940s by Dow Chemical in the US and was used by the US navy as swimming floats. Due to its good thermal insulating properties and moisture resistance, this blue foam soon found its way into the construction of temperature controlled stores and since the early 1950s has also been used most successfully in the building industry. Constant further development of the material and of the technology associated with its production have led to today’s diversified range of products – which offer innovative and efficient solutions for a vast array of applications using STYROFOAM™ extruded polystyrene foam.

1.1.2 Product properties

STYROFOAM™ extruded polystyrene foam is a closed-cell material; it offers a range of properties which are very important for a core material in composite panels: they include:

- **Good thermal insulation**: STYROFOAM™ provides reliable and durable thermal insulation performance.

- **High mechanical strength**: STYROFOAM™ has extremely high strength in compression, tension, bending and shear. Composite panels made with STYROFOAM exhibit high impact strength and resistance to dynamic loading.

- **High water and vapour resistance**: The closed cell structure ensures that STYROFOAM™ retains its performance even when in permanent contact with moisture.

- **Chemical resistance**: STYROFOAM™ material is resistant to most acids and salts.

- **Good bonding properties**: STYROFOAM™ boards have a smooth dust free surface, which provides a very good base for lamination.

- **Lightweight**: STYROFOAM™’s high strenght-to-weight-ratio is particularly important in applications such as camper vans and refrigerated trucks.

- **Long-term performance**: STYROFOAM™ does not rot: its thermal and mechanical properties have been proven long-term.

- **Easy to use**: Due to its homogeneous cell structure and uniform density STYROFOAM™ can be cut very accurately and to very close tolerances.

With all those specific product properties, STYROFOAM™ products are a proven solution to the production of lightweight and highly durable composite panels.
1. Composite panels with a core of STYROFOAM™

1.1.3 Environmental compatibility and durability

Environmental concerns increasingly focus attention on the need for sustainable constructions using materials and structures which offer long-term performance. The properties and performance characteristics of STYROFOAM™ make it a highly efficient material for long-term use in composite panels: product quality and properties are continuously recorded and monitored by Dow’s in-house laboratories and tested by independent institutes. STYROFOAM™ products made with CO₂ as the blowing agent contain air in the foam cells and are identified by the suffix ‘A’; for example STYROFOAM IBF-A. STYROFOAM™ products for specific applications, requiring even lower thermal conductivity, are made using HFC as the blowing agent and are identified by the suffix ‘X’: for example STYROFOAM RTM-X.

1.2 Long-term experience of STYROFOAM™ as a core material tried-and-tested in practice

The idea of sandwich construction dates back to the 19th century, but the technique really came into its own in the 20th century, largely in response to the demands of the aerospace industry to optimise strength-to-weight-ratio. Today, automated methods of production, together with a large selection of facing materials and adhesives, permit the production of composite panels tailored to meet a vast range of requirements in very diverse fields of application. With the development of ever-larger presses, it is today possible to produce sandwich panels in excess of over 12 m long.

STYROFOAM™ boards have been used for more than 40 years as a core material which allows precision processing and which is highly stable in composite panels – over 20 million square metres of such panels, with their ‘blue interior’, have been successfully tried and tested in that time. With this long-term practical experience, Dow has built up a wealth of sound technical and technological know-how – which is particularly important for the successful development of solutions for composite panel production.

1.3 Applications

The fields of use are varied – STYROFOAM™ is used as a core material in the following applications:

››› Trucks for chilled and refrigerated transport
››› Chilled stores
››› Cold storage cells
››› Cold store walls
››› Façade panels
››› Self-supporting roof panels
››› Insulating doors
››› Camper vans and caravans
››› Portable cabins
››› Internal partitions

© ™ Trademark of The Dow Chemical Company (“Dow”) or affiliated companies
A composite panel is a load-bearing, lightweight laminated structure, the performance of which can be analysed in the same way as that of a steel I beam. Bending moments, induced by loading, are resisted by tensile and compressive forces in the facings, whilst the core material absorbs the shear forces (Fig. 04).

The performance and durability of a composite panel depend upon the proper harmonization of its constituent parts and the manufacturing process itself. From decades of experience in a whole range of applications, Dow has built up a vast store of know-how – both on production technologies and on the various components of the composite panel.

2.1 Wide choice of facings
A wide range of sheet materials can be used as facings for lamination to STYROFOAM™ core material (Fig. 5) including:
Wood-based sheets, aluminium, steel, PVC, GRP, gypsum plasterboard, gypsum cellulose fibre and glass.

Fig. 04

2. Production and structure of composite panels with STYROFOAM

Fig. 05

Fig. 06 ➞ Cross-section of an aluminium-faced door panel with a STYROFOAM™ core

STYROFOAM solutions
2.2 Adhesives
Solvent-free adhesives such as 1 and 2-component polyurethane adhesives must be used to adhere the panel facings to the core. Reactive polyurethane, hot-melt, or epoxy adhesives are also used in specific cases and various press technologies are deployed, including vacuum and hydraulic presses and hip rollers.

The choice of adhesive and bonding technique is governed by the strength requirements of the panels to be produced, and their particular application.

2.3 STYROFOAM™ core material
The core material has to absorb the shear forces which occur due to the loading and bending of the composite panel (see Fig. 04).

STYROFOAM™ is ideally suited as a core material because:

- its high compressive strength prevents the facings from buckling.
- it increases the composite panel’s resistance to deflection.
- its shear strength provides a very high shear modulus.

The high shear modulus provided by STYROFOAM™ allows composite panels to be designed with long self-supporting spans, enhanced rigidity and low deflection.

STYROFOAM™ extruded polystyrene foam boards for use in composite panels have planed surfaces and are produced to close dimensional tolerances.

An in-house hot-wire cutting facility enables Dow to produce down to 8 mm thin layers out of STYROFOAM™ blocks. A standard thickness tolerance of +/- 0.5 mm can be achieved with this equipment. On special request Dow can offer material with a special thickness tolerance of +/- 0.1 mm. Boards can be ordered with grooved surfaces which assist the bonding process by allowing air to be driven and the adhesive to spread uniformly.

### Standard tolerances

| Width               | (600 mm width) + 3/- 0 mm  
|                    | (1200 mm width) + 5/- 0 mm |
| Length             | +10/- 0 mm                 |
| Thickness          | +/- 0.5 mm                 
|                    | (custom-made product: +/- 0.1 mm) |

### Other tolerances on request

**Standard grooves:**
3.5 mm deep x 1.8 mm wide at 39 mm centres.

© Trademark of The Dow Chemical Company (“Dow”) or affiliated companies
2. Production and structure of composite panels with STYROFOAM

Laboratory testing
Dow’s extensive test programme includes small-scale dynamic fatigue testing, panel surface temperature measurements, testing the effects of solar exposure, testing large-scale panels to failure and a variety of customised mechanical testing. The endurance properties of the products are evaluated, by performing creep tests.

The research and development department in Rheinmünster conducts product analyses, performs material research and develops new applications.

2.4 Design notes

- Deflection should be calculated in accordance with Euro-Code 1 and be limited to span/300.
- Shear stress should not exceed the maximum allowable shear stress of STYROFOAM™ core material.
- Tensile and compressive stresses should not exceed the maximum allowable stresses of the facing materials or their critical buckling stress.
- Stringent quality control during production is essential for attaining a consistently high level of bonding.
- Where conditions of use make thermal and/or hygroscopic bowing a possibility, this should be taken into account in the panel design.

Professional support for your planning
Thanks to our decades of experience and our close working relationship with our customers, we have extensive knowledge of the technical processes involved in the production of composite panels. Please do not hesitate to contact us if you have any questions relating to the calculation of composite panels – our experts will be pleased to help.
2.5 Composite panel calculations

Before the following calculations can be used, it is essential to ensure continuous bonding between the various layers of the composite panel can be achieved.

For a simply supported composite panel, the deflection can be evaluated using the following equation:

\[ d = k_f \frac{P \cdot L^3}{E \cdot I} + k_c \frac{P \cdot L}{G \cdot A} \]

= flexural deflection + shear deflection

- \( d \) = Deflection
- \( P \) = Load
- \( I \) = Moment of inertia
- \( E \) = Elastic modulus
- \( G \) = Shear modulus
- \( A \) = Area
- \( k \) = specific coefficient

The data refer to a 100 mm thick composite panel with STYROFOAM™ core and aluminium facings exposed horizontally in still air.

Fig. 12 - Panel surface temperature with solar exposure

<table>
<thead>
<tr>
<th>Case</th>
<th>Formula</th>
<th>( k_f )</th>
<th>( k_c )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simply supported beam, uniformly distributed load</td>
<td>( P = p \cdot \frac{L}{3} )</td>
<td>5/384</td>
<td>1/8</td>
</tr>
<tr>
<td>Simply supported beam, central point load</td>
<td>( P = p \cdot \frac{L}{4} )</td>
<td>1/48</td>
<td>1/4</td>
</tr>
<tr>
<td>Simply supported beam, point loads at ( L/4 ) span from the supports</td>
<td>( P = p \cdot \frac{L}{2} )</td>
<td>11/768</td>
<td>1/8</td>
</tr>
<tr>
<td>Cantilever, uniformly distributed load</td>
<td>( P = p \cdot \frac{L}{4} )</td>
<td>1/3</td>
<td>3/4</td>
</tr>
<tr>
<td>Cantilever, point load at free end</td>
<td>( P = p \cdot \frac{L}{2} )</td>
<td>1/3</td>
<td>6/5</td>
</tr>
</tbody>
</table>
3. Composite panels for refrigerated trucks

The technical requirements for refrigerated truck bodies are defined by regulations and by economic considerations, which include the resale value of a vehicle.

To be cost efficient, refrigerated truck bodies must be insulated effectively and reliably whilst also being lightweight and built with highly durable materials to last for decades. By choosing STYROFOAM™ as a core material it is possible to satisfy those requirements.

Panels with STYROFOAM™ core material have been used in the manufacture of floors, walls and roofs of refrigerated truck bodies for more than 25 years with proven success: STYROFOAM LB-X, STYROFOAM RTM-X and STYROFOAM HD 300-X are ideally suited to such applications.

Our specialists will be pleased to assist you in selecting the right STYROFOAM™ product and calculating the required thicknesses for any application.

STYROFOAM™ and its characteristic properties in refrigerated trucks:

Durable thermal insulation
With a closed refrigeration chain and thermally efficient construction, the cargo space can be maintained at a controlled temperature very economically. Furthermore, because of the long-term performance of the STYROFOAM™ core, the cargo space will pass the second ATP test after six years of service.

High mechanical strength
When used in floor panels STYROFOAM™ supports heavy cargo loads and the dynamic loads of fork lift trucks. When used in walls it absorbs high dynamic loads, such as those caused by wind and vibration. When used in roof panels STYROFOAM will support high tensile loading from suspended items.

Moisture resistance
The closed cell structure means that STYROFOAM™ material is resistant to moisture – which is important for the long-term performance of the panel and can help to minimise costs of repair and maintenance.

Easy to use
STYROFOAM™ can be cut to size using conventional woodworking tools and machinery.

Fig. 14 ‹› Well insulated and able to support loads: refrigerated truck bodies using STYROFOAM™ cored panels.

Fig. 15 ›› Detail view of a floor structure

Fig. 16
Another field of application, in which Dow has decades of experience, is the use of STYROFOAM™ as a core material in composite panels used to construct camper vans and caravans. Leading manufacturers benefit from the very high strength-to-weight ratio of composite panels with STYROFOAM in the production of their vehicles.

With camper vans and portable cabins, the long-term thermal performance of STYROFOAM™ insulation plays a significant role.

STYROFOAM™ composite panels provide a high level of rigidity to withstand the vibrations and stresses in the roofs of camper vans, caravans and portable cabins.

Because of the rigidity of STYROFOAM™ XPS it is possible to reduce the number and cross-section of wooden inserts used in floor panels whilst maintaining the required strength.

- **Good thermal insulation**
  Important for long-term comfort at low temperatures during winter operation.

- **High mechanical strength**
  The composite panels provide good rigidity and load-carrying capability and optimise the absorption of dynamic forces and impacts throughout the life of the vehicle.

- **Lightweight**
  Improves fuel efficiency over the life of the vehicle.
5. Composite panels for cladding, windows and doors

The use of lightweight claddings has opened up a whole new perspective in architectural design within Europe – both in new buildings and in the renovation of older ones. Insulated composite cladding panels facilitate rapid construction and offer great flexibility in the choice of the facing materials and finishes.

To be suitable for this application the panel core material must offer high mechanical strength and thermal performance, properties which STYROFOAM™ extruded polystyrene foam possess.

Leading manufacturers of external doors and windows have chosen STYROFOAM™, selecting it for its, convincing properties and performance.

- **Long-term thermal insulation**
  STYROFOAM™ offers highly effective long-term thermal insulating performance.

- **Good mechanical properties**
  Provides the necessary high resistance to mechanical loading and high impact strength.

- **Lightweight**
  Easy to handle in all fields of application.

- **Versatile finish and design options**
  Thanks to the wide choice of materials available as facings.
## 6. Technical Data

<table>
<thead>
<tr>
<th>Properties 1)</th>
<th>CE-Code</th>
<th>Standard</th>
<th>Unit</th>
<th>STYROFOAM\textsuperscript{TM} IBF-A</th>
<th>STYROFOAM LB-A</th>
<th>STYROFOAM IBF-X</th>
<th>STYROFOAM LB-X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>DIN EN 1602</td>
<td>kg/m(^3)</td>
<td>32</td>
<td>33</td>
<td>32</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Thermal conductivity @ 10°C</td>
<td>DIN EN 12667/ DIN EN 12939</td>
<td>W/m K</td>
<td>0,035</td>
<td>0,0355 (≤ 60 mm)</td>
<td>0,0345 (61–80 mm)</td>
<td>0,0355 (&gt; 80 mm)</td>
<td>0,030</td>
</tr>
<tr>
<td>Thermal conductivity (\lambda)</td>
<td>DIN EN13164</td>
<td>W/m K</td>
<td>0,035 (≤ 80 mm)</td>
<td>0,036 (&gt; 80 mm)</td>
<td>0,036 (≤ 80 mm)</td>
<td>0,036 (&gt; 80 mm)</td>
<td>0,033</td>
</tr>
<tr>
<td>(\lambda), design value according to Z-23.15-1476</td>
<td>DIN 4108-4</td>
<td>W/m K</td>
<td>0,037</td>
<td>0,035 (≤ 60 mm)</td>
<td>0,0356 (61–80 mm)</td>
<td>0,037 (&gt; 80 mm)</td>
<td>0,034</td>
</tr>
<tr>
<td>Compressive stress or compressive strength @ 10% deformation (\sigma_{m}) (2))</td>
<td>CS(10/Y)</td>
<td>DIN EN 826</td>
<td>N/mm(^2) (3)</td>
<td>0,25</td>
<td>0,30</td>
<td>0,25</td>
<td>0,30</td>
</tr>
<tr>
<td>Compressive modulus (\sigma_m) (2))</td>
<td>–</td>
<td>DIN EN 826</td>
<td>N/mm(^2)</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Compressive creep (50 years) ≤ 2% deformation (\sigma_{m}) (2)</td>
<td>CC(2/1,5/50)</td>
<td>DIN EN 1606</td>
<td>N/mm(^2)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tensile strength (\sigma_m) (2)</td>
<td>TR400</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>0,45</td>
<td>0,50</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tensile modulus (\sigma_m) (2)</td>
<td>TR600</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tensile modulus (\sigma_m) (2)</td>
<td>TR600</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tensile modulus (\sigma_m) (2)</td>
<td>TR900</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shear strength</td>
<td>–</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>0,2</td>
<td>0,25</td>
<td>0,2</td>
<td>0,25</td>
</tr>
<tr>
<td>Shear modulus</td>
<td>–</td>
<td>DIN EN 12090</td>
<td>N/mm(^2)</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Water vapour diffusion resistance factor ((\mu))</td>
<td>–</td>
<td>DIN EN 12086</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Long term water absorption by total immersion</td>
<td>–</td>
<td>DIN EN 12087</td>
<td>vol.-%</td>
<td>≤ 2</td>
<td>≤ 1,5</td>
<td>≤ 2</td>
<td>≤ 2</td>
</tr>
<tr>
<td>Long term water absorption by total immersion</td>
<td>–</td>
<td>DIN EN 12087</td>
<td>vol.-%</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Dimensional stability under specified temperature and humidity</td>
<td>DS(TH)</td>
<td>DIN EN 1604</td>
<td>%</td>
<td>≤ 5</td>
<td>–</td>
<td>≤ 5</td>
<td>≤ 5</td>
</tr>
<tr>
<td>Reaction to fire</td>
<td>–</td>
<td>DIN 4102</td>
<td></td>
<td>81</td>
<td>81</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>Reaction to fire Euroclasse</td>
<td>–</td>
<td>DIN 13501-1</td>
<td></td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Coefficient of linear thermal expansion</td>
<td>–</td>
<td>–</td>
<td>mm/m K</td>
<td>≤ 0,07</td>
<td>0,07</td>
<td>0,07</td>
<td>0,07</td>
</tr>
<tr>
<td>Temperature limits</td>
<td>–</td>
<td>–</td>
<td>°C</td>
<td>–50/+75</td>
<td>–50/+75</td>
<td>–50/+75</td>
<td>–50/+75</td>
</tr>
<tr>
<td>Capillarity</td>
<td>–</td>
<td>–</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Edge profile</td>
<td>–</td>
<td>–</td>
<td></td>
<td>butt</td>
<td>butt</td>
<td>butt</td>
<td>butt</td>
</tr>
<tr>
<td>Surface finish</td>
<td>–</td>
<td>–</td>
<td></td>
<td>planed</td>
<td>planed</td>
<td>planed</td>
<td>planed</td>
</tr>
<tr>
<td>Dimensions (4)\</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td>–</td>
<td>DIN EN 823</td>
<td>mm</td>
<td>20 – 120</td>
<td>20 – 120</td>
<td>20 – 120</td>
<td>20 – 160</td>
</tr>
<tr>
<td>Width</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>600</td>
<td>600</td>
<td>600/1200</td>
<td>600/1200</td>
</tr>
<tr>
<td>Length</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>Tolerances (4)\</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness (T1)</td>
<td>–</td>
<td>DIN EN 823</td>
<td>mm</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Width &lt; 700 mm</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–/0/+3</td>
<td>–/0/+3</td>
<td>–/0/+3</td>
<td>–/0/+3</td>
</tr>
<tr>
<td>Width ≥ 700 mm</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–</td>
<td>–</td>
<td>–/0/+5</td>
<td>–/0/+5</td>
</tr>
<tr>
<td>Length</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–/0/+10</td>
<td>–/0/+10</td>
<td>–/0/+10</td>
<td>–/0/+10</td>
</tr>
<tr>
<td>Applications (5)\</td>
<td>–</td>
<td>DIN 4108, T 10</td>
<td></td>
<td>WAB, WAP, WI</td>
<td>WAB, WAP, WI</td>
<td>WAB, WAP, WI</td>
<td>WAB, WAP, WI</td>
</tr>
<tr>
<td>Governmental standard</td>
<td>XPS-EN13164</td>
<td></td>
<td></td>
<td>T3-CS(10/10)</td>
<td>T3-CS(10/10)-DS(TH)-TR400</td>
<td>T3-CS(10/10)</td>
<td>T3-CS(10/10)-DS(TH)-TR400</td>
</tr>
</tbody>
</table>

1) The properties refer to thickness ranges mentioned in the table.
2) Measured in thickness direction
3) 1 N/mm\(^2\) = 10\(^3\) kPa; 1 kPa = 10\(^{-3}\) MPa
4) Products with special dimensions or closer tolerances may be available upon request.
5) Only valid for the use of products in building applications. Details are given for potential applications, which however for the final building product need to be defined by its fabricator.

\(\text{TM}\) Trademark of The Dow Chemical Company ("Dow") or affiliated companies.

---

1) The properties refer to thickness ranges mentioned in the table.
2) Measured in thickness direction
3) 1 N/mm\(^2\) = 10\(^3\) kPa; 1 kPa = 10\(^{-3}\) MPa
4) Products with special dimensions or closer tolerances may be available upon request.
5) Only valid for the use of products in building applications. Details are given for potential applications, which however for the final building product need to be defined by its fabricator.

\(\text{TM}\) Trademark of The Dow Chemical Company ("Dow") or affiliated companies.
<table>
<thead>
<tr>
<th>Properties</th>
<th>CE-Code Standard</th>
<th>Unit</th>
<th>STYROFOAM™ RTM-X</th>
<th>STYROFOAM HD 300-F-X</th>
<th>STYROFOAM FB-X</th>
<th>STYROFOAM SP-X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>DIN EN 1602</td>
<td>kg/m³</td>
<td>40</td>
<td>45</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td>Thermal conductivity @ 10°C</td>
<td>DIN EN 12667/ DIN EN 12939</td>
<td>W/m·K</td>
<td>0,025</td>
<td>0,025</td>
<td>0,030</td>
<td>0,026</td>
</tr>
<tr>
<td>Thermal conductivity λ2</td>
<td>DIN EN13164</td>
<td>W/m·K</td>
<td>0,029 (≤ 120 mm)</td>
<td>0,029 (≥ 120 mm)</td>
<td>0,029</td>
<td>0,033</td>
</tr>
<tr>
<td>λ, design value according to Z-23.15-1476</td>
<td>DIN 4108-4</td>
<td>W/m·K</td>
<td>0,029 (20 – 70 mm)</td>
<td>0,029 (40 – 70 mm)</td>
<td>0,034</td>
<td>0,029</td>
</tr>
<tr>
<td>Compressive stress or compressive strength @ 10% deformation</td>
<td>CS(10/Y)</td>
<td>DIN EN 826</td>
<td>N/mm²</td>
<td>0,4</td>
<td>0,7</td>
<td>0,20</td>
</tr>
<tr>
<td>Compressive modulus</td>
<td>DIN EN 826</td>
<td>N/mm²</td>
<td>15</td>
<td>25</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Compressive creep (50 years) ≤ 2% deformation</td>
<td>CC(2/1,5/50/2n)</td>
<td>DIN EN 1606</td>
<td>N/mm²</td>
<td>–</td>
<td>0.21</td>
<td>–</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>TR400</td>
<td>DIN EN 1607</td>
<td>N/mm²</td>
<td>0.7</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>DIN EN 1607</td>
<td>N/mm²</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shear strength</td>
<td>DIN EN 12909</td>
<td>N/mm²</td>
<td>0,4</td>
<td>0,5</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shear modulus</td>
<td>DIN EN 12909</td>
<td>N/mm²</td>
<td>10</td>
<td>14</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Water vapour diffusion resistance factor (μ)</td>
<td>–</td>
<td>DIN EN 1286</td>
<td>–</td>
<td>150</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>Long term water absorption by total immersion</td>
<td>WLT(T1,5)</td>
<td>DIN EN 12087</td>
<td>Vol.-%</td>
<td>≤ 1</td>
<td>–</td>
<td>≤ 1,5</td>
</tr>
<tr>
<td>Long term water absorption by total immersion</td>
<td>WLT(T1,07)</td>
<td>DIN EN 12087</td>
<td>Vol.-%</td>
<td>≤ 0.7</td>
<td>–</td>
<td>≤ 0.5</td>
</tr>
<tr>
<td>Dimensional stability under specified temperature and humidity</td>
<td>D5(TH)</td>
<td>DIN EN 1604</td>
<td>%</td>
<td>≤ 2</td>
<td>≤ 2</td>
<td>≤ 2</td>
</tr>
<tr>
<td>Deformation under specified compressive load and temperature</td>
<td>DLT(2)5</td>
<td>DIN EN 1605</td>
<td>%</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>–</td>
</tr>
<tr>
<td>Reaction to fire</td>
<td>DIN 4102</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Reaction to fire Euroclass</td>
<td>EN 13501-1</td>
<td>–</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Coefficient of linear thermal expansion</td>
<td>–</td>
<td>DIN EN 823</td>
<td>mm/m·K</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Temperature limits</td>
<td>–</td>
<td>–</td>
<td>°C</td>
<td>–50/+75</td>
<td>–50/+75</td>
<td>–180/+75</td>
</tr>
<tr>
<td>Capillarity</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Edge profile</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>butt</td>
<td>butt</td>
<td>butt</td>
</tr>
<tr>
<td>Surface finish</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>planed/grooved</td>
<td>planed/grooved</td>
<td>planed</td>
</tr>
<tr>
<td>Dimensions</td>
<td>–</td>
<td>DIN EN 823</td>
<td>mm</td>
<td>20 – 120</td>
<td>40 – 100</td>
<td>200</td>
</tr>
<tr>
<td>Thickness</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>600/1200</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Length</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>Thickness</td>
<td>T3</td>
<td>DIN EN 823</td>
<td>mm</td>
<td>–0.5/+0.5</td>
<td>–0.5/+0.5</td>
<td>–1/+1</td>
</tr>
<tr>
<td>Width &lt; 700 mm</td>
<td>T1</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–0/+3</td>
<td>–0/+3</td>
<td>–0/+3</td>
</tr>
<tr>
<td>Width ≥ 700 mm</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–0/+5</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Length</td>
<td>–</td>
<td>DIN EN 822</td>
<td>mm</td>
<td>–0/+10</td>
<td>–0/+10</td>
<td>–0/+10</td>
</tr>
<tr>
<td>Applications</td>
<td>–</td>
<td>DIN 4108, T 10</td>
<td></td>
<td>DAD, WAB</td>
<td>DAD, WAB</td>
<td>–</td>
</tr>
<tr>
<td>Governmental standard</td>
<td>XPS-EN13164</td>
<td></td>
<td></td>
<td>T3-CS(10/Y)400-DS(TH)-TR600</td>
<td>T3-CS(10/Y)700-CC-WLT</td>
<td>T3-CS(10/Y)900-CC-WLT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T1-CS(10/Y)300-DS(TH)</td>
<td>CC(2/1,5/50110)</td>
<td>WLT(10,7)</td>
</tr>
</tbody>
</table>

6) Temperature limit –180 °C only for pipe shells
7) Compressive strength ≥ 0.35 N/mm²
8) Measured after 60 days
7. Notes

Please note the Material Safety Data Sheets published by Dow. STYROFOAM™ boards contain a flame retardant additive to inhibit accidental ignition from a small fire source. The boards are, however, combustible and, if exposed to an intensive fire, may burn rapidly. During shipment, storage, installation and use they should not be exposed to flames or other ignition sources. In most countries fire classifications are based on small-scale tests which may not reflect the reaction of the product in its end-use state under actual fire conditions. STYROFOAM boards should, when installed, be adequately protected from direct exposure to fire as directed by national regulations. The national regulations set out the requirements for the fire performance. Polystyrene products will melt when brought into direct contact with high temperature heat sources: for Dow STYROFOAM™ boards the recommended maximum working temperature is 75 °C.

The use of solvent-free adhesive is recommended. Advice on compatibility with polystyrene foam should be sought from the adhesive manufacturers prior to application. Solvent attack may occur if STYROFOAM™ boards are in direct contact with materials which contain volatile organic components eg solvents.

Protect STYROFOAM™ from prolonged exposure to intense sunlight to prevent degradation of the surface of the board. STYROFOAM™ boards should be stored on a clean, flat surface in an area free from flammable or volatile materials. When large quantities of the boards are stored indoors, the building should be ventilated to allow a minimum of two air changes per hour. When stored for long periods in the open, the boards should be protected from direct sunlight to avoid degradation.

Light coloured plastic sheeting is a suitable protective cover. Avoid dark materials as excessively high temperatures may develop beneath them.

Recommendations about the methods, use of materials and construction details are given as a service to designers and contractors. These are based on the experience of Dow with the use of STYROFOAM™ boards. Any drawings are meant only to illustrate various possible applications and should not be taken as a basis for design. Since Dow is a materials supplier and exercises no control over the installation of STYROFOAM boards, no responsibility is accepted for such drawings and recommendations.

In particular, no responsibility is accepted by Dow for the systems in which STYROFOAM™ is used or the method of application by which it is installed. The legal obligations of Dow in respect of any sale of STYROFOAM boards shall be determined solely by the terms of the respective sales contract.

No freedom from any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Dow assumes no obligation or liability for the information in this document.

No warranties are given; all implied warranties of merchantability or fitness for a particular purpose are expressly excluded.
8. Table of images

Cover picture + Fig. 7
Carrosseriefabriek Heiwo bv,
8471 AD Wolvega, Netherlands

Fig. 2
Pecolit Kunststoffe GmbH & Co. KG,
Pechhüttenstr. 8, 67105 Schifferstadt,
Germany

Fig. 5 + 6
Stadur Süd Dämmstoff-Produktions GmbH,
72124 Pliezhausen, Germany

Fig. 14 + 16
Schmitz Cargobull AG, 48612 Horstmar
Germany

Fig. 17 + 18
Frankia Fahrzeugbau Pilote GmbH & Co. OHG,
95509 Marktschorgast, Germany

Fig. 19
IFN-Internorm Bauelemente GmbH & Co. KG,
4050 Traun, Austria

Fig. 20 + 21
Weiss Chemie + Technik GmbH & Co. KG,
35703 Haiger, Germany