

Insulation systems for metal and special roofs

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Building



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Aesthetics and a long service life

In bygone centuries, metal was already being used as the roof covering material for technically and aesthetically demanding buildings. Even then, great master builders recognised the advantages. Metal's long service life and adaptability – even in complex roof landscapes – is very highly valued by architects and building contractors today as well. And in fact, more and more. In combination with a highly effective thermal insulation of FOAMGLAS® – the safety insulation made of glass foam – metal and special roofs can also prove to be economically viable because of the long term performance.

A variety of design possibilities, economically

Metal roofs are unquestionably on the way up. For a long time people have been discovering the material no longer just on churches, on public or commercial buildings – it is being used more and more in residential buildings as well. Because even the most striking roof shapes can be clad with metal. Another thing that makes architects and clients equally happy: Not only is something offered to the eyes: In addition to aesthetics, metal roofs fulfil the

- 1 Spa, Alveneu
- 2 Penthouse, Palace Hotel, Gstaad
- 3 Eglise Ste-Thérèse de Lisieux, Fribourg



most demanding requirements in terms of service life, and therefore economics. Since metal roofs are nearly maintenance-free when expertly installed, the roof is also very economical in the long term.

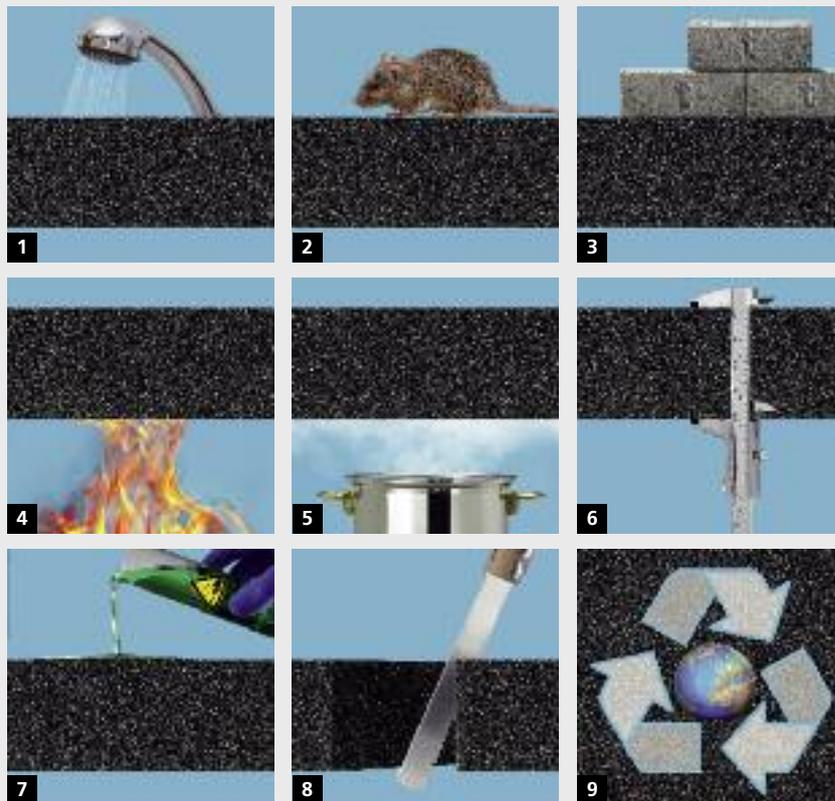
Ecologically sensible system solutions

The “natural” building material is also valued for its positive ecological balance sheet. Economics and ecology are virtually merged in it, and add value to structures. Metal roofs emphasise their ecological attractiveness because, for example, after the end use of the building both the covering materials and the insulation – if it consists of FOAMGLAS® – can be recycled. While metals can be re-used in a closed cycle for the production of “fresh material”, the glass foam insulation can be used, for instance, as insulating back filler material.

Crucial criterion: Long service life

Here metal especially distinguishes itself: Thus for example aluminium metal sheet roofs 100 years old are encountered all over Europe. And the copper roof of the Hildesheim cathedral has been “free of damage” for nearly 300 years. Titanium zinc alloy and high-grade steel, with applications appropriate to the system, also show a considerable expected service life according to current knowledge. Thus it is not surprising that both public and private clients increasingly bet on the functionality, the safety and the aesthetics of metal.

FOAMGLAS® insulation: unrivalled performance



- 1 **Waterproof** FOAMGLAS® is waterproof because it consists of pure glass. **Advantage:** does not absorb any moisture and does not swell.
- 2 **Pest-proof** FOAMGLAS® cannot rot and is pest-proof because it is inorganic. **Advantage:** insulation without risk, especially in the base area and the soil. No basis for nesting, breeding or seed germination.
- 3 **Compression-proof** FOAMGLAS® is extraordinarily in-compressible even with long-term loads due to its cell geometry without deformation. **Advantage:** use as load-bearing thermal insulation without risk.
- 4 **Incombustible** FOAMGLAS® cannot burn because it consists of pure glass. Fire behaviour: Classification according to EN 13501: A1. **Advantage:** storage and processing not hazardous. No propagation of flames in the event of fire (chimney effect) in ventilation space.
- 5 **Vapour-tight** FOAMGLAS® is vapour-tight because it consists of hermetically sealed glass cells. **Advantage:** cannot soak through and already contains the vapour barrier. Constant thermal insulation value over decades. Prevents the penetration of radon.
- 6 **Dimensionally stable** FOAMGLAS® is dimensionally stable because glass neither shrinks nor swells. **Advantage:** no dishing, contracting or creep. Low coefficient of expansion, nearly equal to that of steel and concrete.
- 7 **Acid-resistant** FOAMGLAS® is resistant to organic solvents and acids because it consists of pure glass. **Advantage:** no destruction of the insulation by aggressive mediums and atmospheres.
- 8 **Easy to work with** FOAMGLAS® is easy to work with because it consists of thin-walled glass cells. **Advantage:** with simple tools like a saw blade or hand saw, FOAMGLAS® can be cut to any desired measurement.
- 9 **Ecological** FOAMGLAS® is free of environmentally damaging flame retardants and propellants, no relevant eco-toxic components. **Advantage:** After generations of use as thermal insulation, FOAMGLAS® can be used again: as filler in landscaping or thermally insulating granulate. Ecologically sensible recycling through re-use.



- 1 Cendres et Métaux, Biel
- 2 Mattenhof school building, Zurich
- 3 University, Zurich
- 4 Central Bank, Vaduz

Flawless construction

It is essential, in combination with roof substrates or insulating materials, to choose the building components that represent both an ideal combination of materials with metal and also guarantee lasting flawless thermal and building physics operation.

FOAMGLAS® insulation is outstandingly suitable for the building and insulating of metal roofs. Various system solutions guarantee that the monocoque unventilated roof in combination with metal sheet covering is one of the safest and technically advanced options.

As a result the tiresome discussion of “warm roof – yes or no” can finally come to an end.

Secure basis for the non-ventilated metal roof

FOAMGLAS® has clear advantages over traditional insulating materials. The safety insulation consists of glass foam. Millions of the smallest, gas filled glass cells give it a high degree of thermal insulating capability. The vapour barrier is already “built in” in the structure of the material.

Glass foam is the only insulating material therefore that takes over the assignment of thermal insulation and vapour barrier in a single function.

In addition the high compressive strength supplies the special argument that the fastening of the metal sheet roof takes place not in the load-bearing base, but through adhering in the insulation layer itself. It is therefore free of thermal bridges.

Special roof systems

Both in new builds and in renovation projects there are roof structures that can be characterised as “special roof

systems". They are usually chosen for architectural, practical or acoustic reasons. Even though this does not explicitly concern flat roofs, the demands of the insulation are comparable with those of a flat roof.

For decades the "FOAMGLAS® compact roof principle" has proven itself due to its extraordinary properties. The reference examples are meant to demonstrate that FOAMGLAS® can also be used extremely advantageously for special

roofs – with the most varied geometrical shapes, with smooth or curved surfaces and/or special covering materials and substrate structures.

Characteristics of warm roof construction with FOAMGLAS®

- Roof structure with long service life due to the combination of age-resistant building materials
- High-performance thermal protection with simultaneous lower structure heights
- Insulation value constant over the full operating life of the building
- Simple build-up in terms of structure and methods
- High building physics safety and low susceptibility to damage
- Minimal fire load; no propagation of fire
- Economical
- Independent of the roof slope with any roof size
- Can be used for practically all roof architectures



In the execution of metal roofs, titanium zinc alloy, aluminium, copper and stainless steel are in the foreground. These materials are processed on FOAMGLAS® according to the specialist rules of the metal roof contracting trade.

1 Copper
 2 Titanium zinc alloy
 3 Aluminium
 4 High-grade steel



Metal roof systems

University of Zurich, Zurich

Architect Calatrava Santiago Valls SA, Zurich

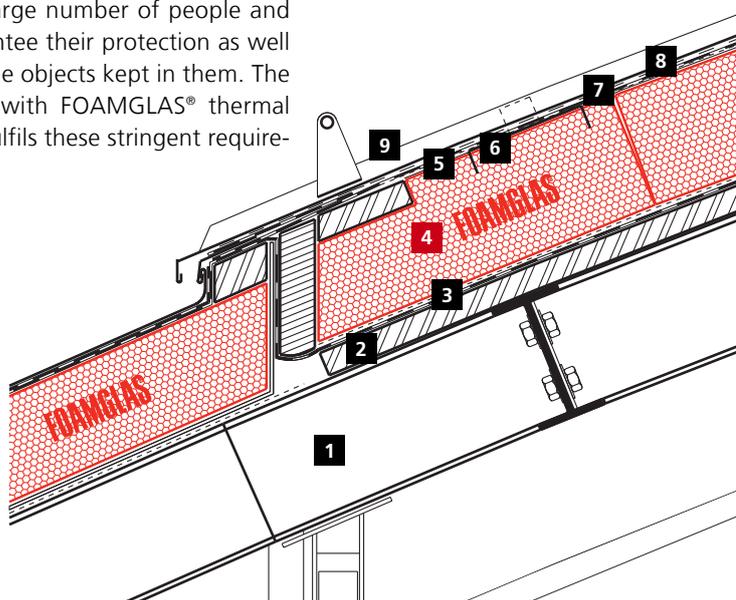
Execution 2002

Use of FOAMGLAS® roof insulation, ca. 1000 m², Type T4+, Thickness 150 mm, adhered

Covering Pre-patined copper sheet metal covering, using the standing seam technique

When architects look for new aesthetic forms of expression, correspondingly innovative solutions are demanded. It is also not surprising that in building projects that are the focus of public interest, like the University of Zurich, special requirements are made. These buildings have to meet especially high safety standards because they accommodate a large number of people and must guarantee their protection as well as that of the objects kept in them. The metal roof with FOAMGLAS® thermal insulation fulfils these stringent require-

ments, in terms of both aesthetics and safety. FOAMGLAS® offers great building physics safety, is non-combustible and in the event of a fire, does not propagate the flames. At the same time it provides long-lived, high-performance thermal protection that remains unchanged over decades.



Aesthetics and safety united

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Build-up

- 1 Steel beams
- 2 Wooden laminated boards
- 3 Separating layer of bitumen membrane
- 4 FOAMGLAS® T4+, 150 mm, in hot bitumen
- 5 Hot bitumen casting
- 6 PC fastening boards (claw plates)
- 7 Waterproofing single layer, bituminous,
- 8 Separating layer, sound insulating fleece
- 9 Pre-patined copper metal sheet covering





Metal Roof Systems

Neues Museum, Museum Island, Berlin

Architects Association of Architects David Chipperfield, Berlin

TGA Planung: JMP Jaeger, Mornhinweg+Partner, Berlin

Construction 2005–2009

FOAMGLAS® application Compact Roof, 1500 m², Type T4+ Tapered; and 2500 m², Type T4+, thickness 100–150 mm, adhered

Covering Metal roofing, pre-patinated copper standing seam

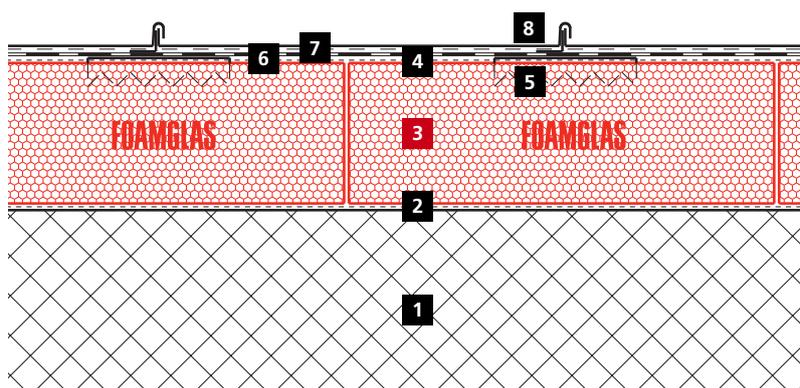
The “Neues Museum” is a museum in Berlin, Germany, on Museum Island. This beautiful building testifies to the neoclassical architecture of museums in the 19th century. The museum houses the Egyptian collection including Papyrus and other works of art, like the famous Nefertiti bust, collected from the time of King Akhenaten. It also houses the Prehistoric and Early History collections. The museum was built between 1843 and 1855 from the design plans by Friedrich August Stüler. It was closed at the beginning of World War II in 1939 but 70 years later the rebuilding was overseen by the English architect David

Chipperfield and officially reopened in October 2009. In 2010 it received the RIBA European Award for architecture. In 1999, the Museum complex was also added to the UNESCO list of World Heritage Sites.

FOAMGLAS® creates the perfect fusion between high performance and aesthetics when a standing seam roof is specified. Cold bridging is totally eliminated by means of the unique fixing system. FOAMGLAS® is guaranteed to perform for the lifetime of the building. What better can we expect to cover and protect a museum houses pieces of art?

Thermally optimised roof structure

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Build-up

- 1 Concrete deck
- 2 Bituminous primer
- 3 FOAMGLAS® T4+ Tapered, adhered with hot bitumen
- 4 Flood coat of hot bitumen
- 5 Metal plates PC® SP 150/150
- 6 Bituminous waterproofing membrane
- 7 Separation layer
- 8 Copper standing seam





Metal standing seam roof over aqua-park

Aquapark, Brno – Kohoutovice – CZ

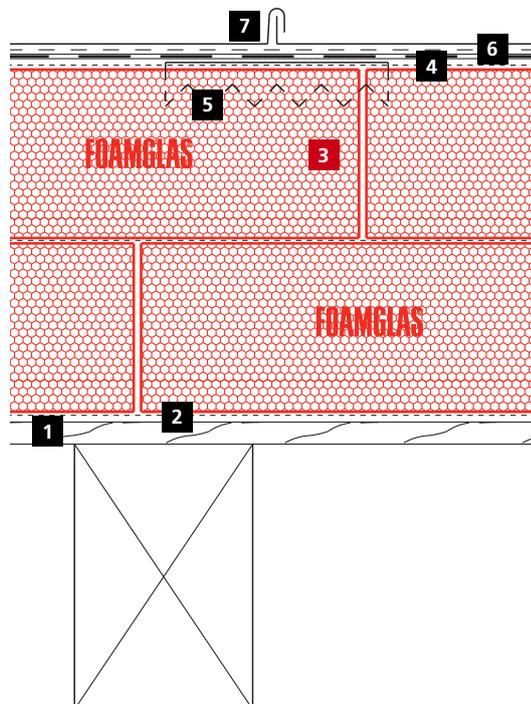
Architect Atelier K4, Brno

Construction 2009–10

Build-up FOAMGLAS® Compact Roof with Metal standing seam roof, 2200 m²
260 mm type T4 in 2 layers and 260 mm Ready Block in 1 layer, with serrated plates and bituminous membrane fully torched

Surface finish Rheinzink Metal standing seam roof

The architects do not like limits... Architecturally interesting concept of the aqua-park roof with the "armadillo" shape and with metal standing seam roof was confronted with the severe conditions of building physics in roofs over swimming pools. Also the strict standards for roof U-value in Czech Republic had to be taken into account. After roofing experts evaluation the only one type of roof build-up could be used – FOAMGLAS® compact roof. No other roof system could enable to create such a difficult shaped and elegantly slim roof – but in the same time roof subjected to intensive diffusion of water vapour. On FOAMGLAS® compact roof build-up it is possible to create smooth, uninterrupted metal standing seam finish continuously passing from roof to façade.



Thermally optimised roof structure
www.foamglas.com

Build-up

- 1 Wooden structure and OSB board
- 2 Bituminous primer
- 3 FOAMGLAS® T4 Slabs
2 x 130 mm, Compact roof system in hot bitumen
- 4 Waterproofing membrane (1 layer)
- 5 PC® Metal plates 15 x 15 cm
- 6 Separation
- 7 Metal sheet





Metal roof systems

Ruggell church, Ruggell (Principality of Liechtenstein)

Architect Architekturbüro Bargetze + Partner, Vaduz, Principality of Liechtenstein

Execution 1999

Use of FOAMGLAS® roof insulation, ca. 200 m², Type T4+, thickness 140 mm, adhered

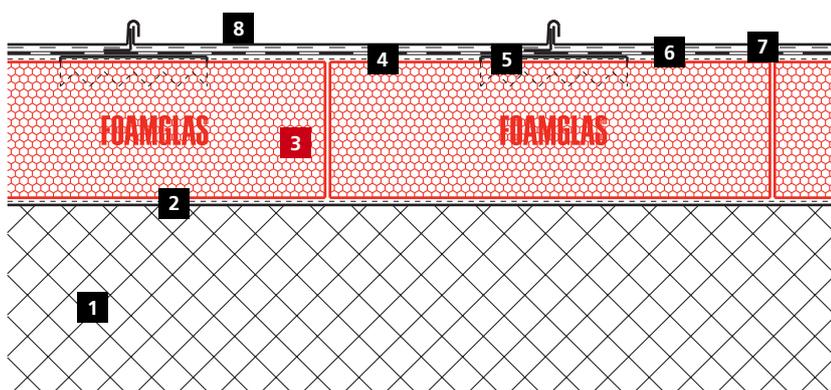
Covering of Uginox with standing seam technique

If there is a requirement for design reasons, as there is here, for a flat sloping sheet metal roof, the prerequisites for thermal operation are no longer present. Ventilation and dehumidification of the insulation are then prevented. What can be done? With FOAMGLAS®, the vapour and water-tight insulation material of glass foam, unventilated

roof structures can be executed in an optimum way. FOAMGLAS® is insulation layer, vapour barrier and load-bearing ceiling substrate for the metal roof in one.

Where there is no moisture, no moisture has to be removed

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Build-up

- 1 In-situ concrete, in the fall
- 2 Bituminous primer
- 3 FOAMGLAS® T4+, 140 mm, in hot bitumen
- 4 Hot bitumen casting
- 5 PC fixing plates (claw plates)
- 6 Single layer waterproofing, bituminous
- 7 Fleece separating layer
- 8 Sheet metal covering of Uginox





Metal roof system

“U” Tower, Dortmund. Centre for Modern Art & Creativity

Client City of Dortmund, Germany. Special funds

Architect Gerber Architekten GmbH, Dortmund

Construction 2010 redevelopment

FOAMGLAS® applications Metal roof system; 950 m², FOAMGLAS® READY BOARD, 110 mm thick, bonded

In total 8,300 m² of FOAMGLAS® for different applications

Covering Copper sheets, 0.7 mm thick, standing seam technique

“U” Tower in Dortmund is a listed industrial building, where in the past the traditional Union-Beer was conditioned in open pools. Today the building has become a powerful flagship for the region where the shift from an industrial age to the new Media Age is on the way. For the Ruhr 2010 event European Capital of Culture, the converted new Centre for Modern Arts and the Creative Industry got their start. An ambitious redevelopment scheme specified, the original brick façade being conserved. Protection of the building’s structure and improvement for the room conditions was achieved by the use of FOAMGLAS® interior insulation.

For the 7th floor, the original metal roof was replaced by a FOAMGLAS® warm roof with copper standing seam sheets. The FOAMGLAS® system is installed on steel deck sloping at 45°. The benefits add up to:

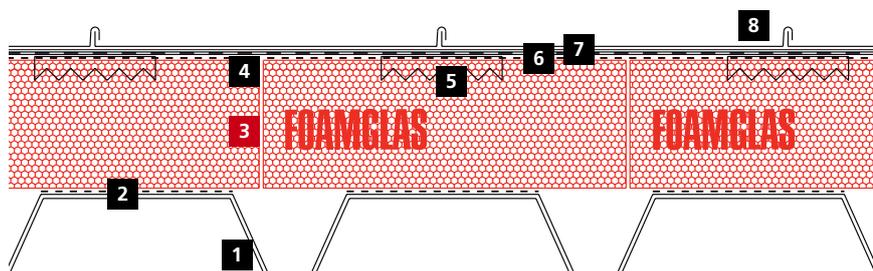
- Monocoque unventilated metal covering which means slim construction.
- Hardly any thermal bridges.
- With a slim roof structure the connection at the crown and the eaves is much easier.
- Elegant, technically fine solution that allows the visitor to see the roof at close.
- FOAMGLAS® is all-in-one insulating layer, vapour barrier and incompressible underlayment for the waterproofing and the sheet metal.

Inspiration for creative minds

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Build-up

- 1 Steel deck, sloping at 45°
- 2 Adhesive, type SK-Fix
- 3 FOAMGLAS® READY BOARD, 110 mm, bonded with SK-Fix adhesive
- 4 Melttable protective bitumen-backed layer
- 5 PC® fixing plates (claw plates)
- 6 Single layer torch-on waterproofing, type polymer-bitumen PYE PV 200 S5
- 7 Fleece separating layer
- 8 Copper sheet metal covering, 0.7 mm thick





Roof with metal covering

Armed Forces Officers Club Abu Dhabi, UAE

Architect Roger Taillibert, France

Execution refurbishment of roof buildup 2006

Application of FOAMGLAS® on concrete shell with metal covering 25 000 m²

The Officers Club in Abu Dhabi build in the nineties as Hotel and conference centre is still a popular hotel in the modern Abu Dhabi with comfortable rooms and place for banquets and meetings. The project often is visited because of its interesting architecture designed from the France Architect Roger Taillibert in a remarkable concrete structure. End of the nineties the roof required a refurbishment of the initially use sprayed Polyurethane thermal Insulation and waterproofing which

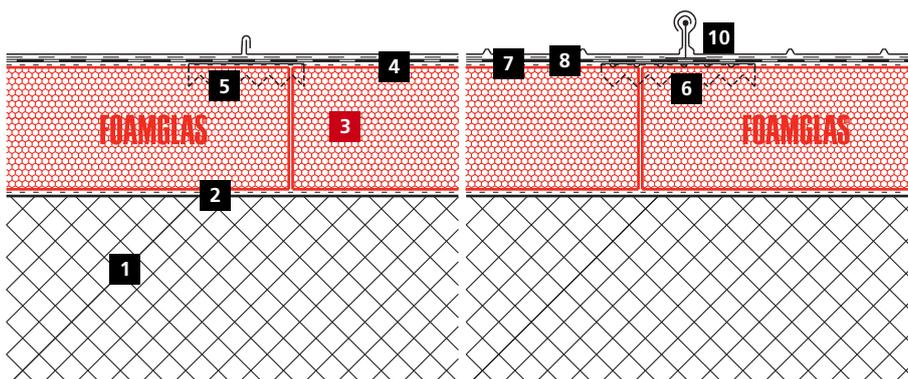
failed already. The client followed the architect's recommendation and chooses the FOAMGLAS® compact roof buildup with a metal roof covering. Because of the unique properties of the cellular glass insulation which can never absorb any moisture, is non-combustible, no degradation and the highest safety in long term, the building is now protected for the next decades!

Do it with FOAMGLAS® and you don't have to do it again

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Build-up

- 1 Concrete roof deck
- 2 Primer coat
- 3 FOAMGLAS® slabs, laid in hot bitumen
- 4 Top coat of hot bitumen
- 5 PC® metal fixing plate 150 x 150 mm
- 6 PC® metal fixing plate 200 x 200 mm
- 7 Bituminous waterproofing membrane
- 8 Separating layer
- 9 Standing seam metal sheet
- 10 Profiled metal sheet





Museum, metal roof system

Foto Meletitiki -
Alexandros Tombazis

Archeological Museum, Delphi

Owner Hellenic Ministry of Culture

Architect Meletitiki – Alexandros Tombazis, Athens

Construction Refurbishment, 2002

FOAMGLAS® application Roofs with metal covering/metal standing seam roofs, 1.152 m², type READY BOARD, 70 mm thick

Roof finish Metal standing seam sheets

The building was first renovated in 1958. In 2002 another renovation took place by today's prominent Greek architect Alexandros Tombazis. If there is a requirement for design reasons, as in this case, for a flat sloping sheet metal roof, the prerequisites for thermal circulation are not given. Ventilation and dehumidification of the insulation are prevented in low sloping constructions. What can be done? With FOAMGLAS®, the vapour- and water-proof cellular glass insulation, unventi-

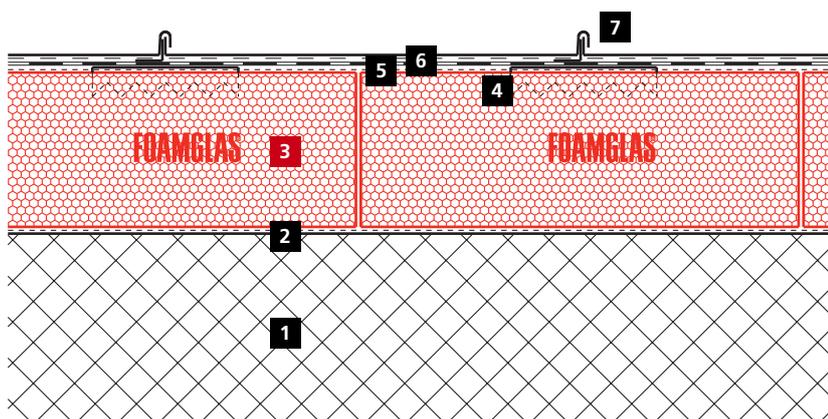
lated roof structures can be built in an optimum way. FOAMGLAS® READY BOARD is insulation layer, vapour-barrier and load bearing subconstruction for the metal standing seam sheets.

The support of the metal covering on FOAMGLAS® was done with timber lathing, a technique that some workers are more familiar with.

The other nowadays widely used technique is to use PC fixing plates (claw plates) which are pressed and hot-bonded to the insulation surface.

**FOAMGLAS®
insulation,
vapour-barrier and
load bearing subcon-
struction**

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Roof structure

- 1 Concrete deck, sloping
- 2 Bitumen based primer
- 3 FOAMGLAS® READY BOARD, 70 mm, glued
- 4 PC fixing plates (claw plates)
- 5 Torch-on waterproofing membrane
- 6 Fleece separating layer
- 7 Sheet metal covering, standing seam





Metal roof systems

Penthouse Palace Hotel, Gstaad

Architect Jaggi & Partner AG, Architektur und Planung, Gstaad

Execution 2000

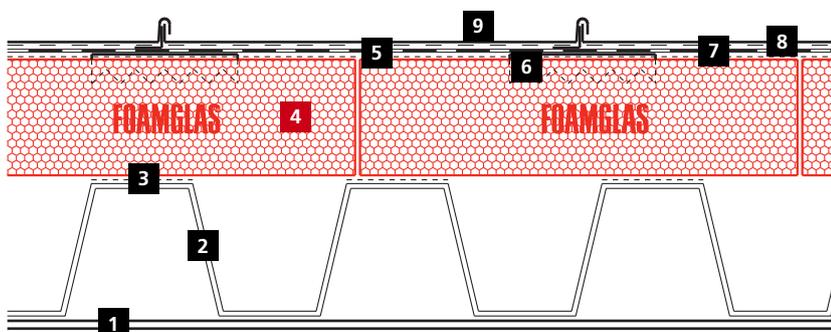
Use of FOAMGLAS® roof insulation, ca. 250 m², Type T4+, thickness 120 mm, adhered

Covering of VM ZINC+ sheet metal using standing seam technique

The monopitch roof sloping slightly to four sides is the combination of a steel substrate structure with a steel deck covering, the FOAMGLAS® is adhered to it and finished with a covering of titanium zinc alloy sheet metal. This structure and choice of materials, innovative for the region, has proven to be an elegant solution whose advantages cannot be overlooked: aestheti-

cally as well as ecologically and economically. Here in the mountains one further system advantage is demonstrated: The roof has proven itself equal to even the highest degree of wind suction. Without additional mechanical fastening! This is hardly conceivable with any other material.

A choice of materials that is great in aesthetic, ecological and economic terms
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Build-up

- 1 Steel girder structure
- 2 Steel deck
- 3 Bituminous primer
- 4 FOAMGLAS® T4+, 120 mm, in hot bitumen
- 5 Hot bitumen casting
- 6 PC fixing plates (claw plates)
- 7 Single layer waterproofing, bituminous
- 8 Fleece separating layer
- 9 VM Zinc+ sheet metal covering





Metal roof systems

Multi-purpose building, Dornbirn (Austria)

Architect ARGE Dipl. Ing. Leopold Kaufmann, Dipl. Ing. Oskar Leo Kaufmann, BM Johannes Kaufmann

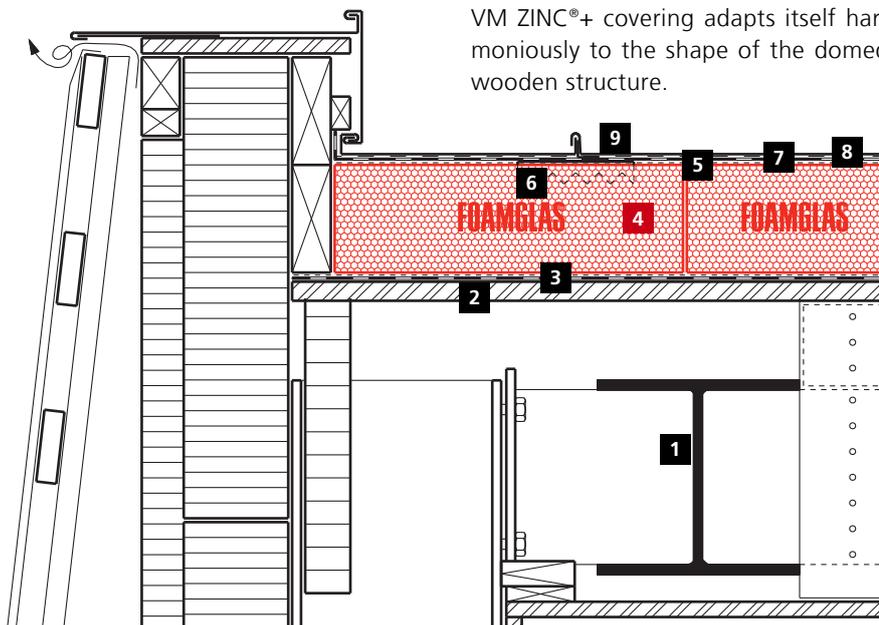
Execution 1998

Use of FOAMGLAS® roof insulation ca. 5000 m², Type T4+, thickness 140 mm, adhered

Covering of VM Zinc Quartz+ sheet metal, using standing seam technique

From the point of view of the architects, the special shape of the building suggested a sheet metal covering from the beginning. The choice fell unambiguously on VM ZIN® QUARTZ+. For building physics reasons the FOAMGLAS®

compact roof proved to be the ideal solution for the 80 m long roof surface which is often covered by winter snow. The 140 mm thick insulation layer results in a functioning vapour barrier. In the roof there are no uncontrolled air layers or intermediate spaces. The VM ZINC®+ covering adapts itself harmoniously to the shape of the domed wooden structure.



Innovative roof structure with long-term safety

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Build-up

- 1 Steel girders
- 2 Wooden shell
- 3 Separating layer of Bitumen sheeting, nailed up for storm proofing
- 4 FOAMGLAS® T4+, 140 mm, in hot bitumen
- 5 Hot bitumen casting
- 6 PC fixing plates (claw plates)
- 7 Single layer waterproofing, bituminous
- 8 Fleece separating layer
- 9 VM Zinc Quartz+ sheet metal covering





Metal roof systems

Museum Tinguely / Niki de Saint Phalle, Fribourg

Architect Michel Waeber Architekt (Project), Jean-Claude Sauterel, Fribourg (Supervision of works)

Execution 1998

Use of FOAMGLAS® roof insulation, ca 500 m², Type T4+, thickness 100 mm, adhered

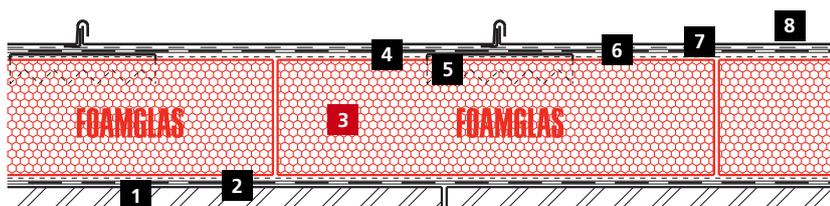
Covering of VM Zinc Quartz+ sheet metal, using standing seam technique

Here a century-old railway station with a turbulent history recently converted into a museum. Thanks to FOAMGLAS® it was possible to keep and enhance the old building structure. Museums are meant to protect: Therefore especially high standards are also imposed for the building quality. This is true as well for the insulating material. The greatest attention must also be paid to

passive fire protection. FOAMGLAS® fulfils these demands. It is not combustible (Fire index number 6.3) and among insulating materials it is the only material that neither smoulders nor gives off black smoke.

FOAMGLAS® fulfils the stringent expectations in terms of quality, long service life and fire protection

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Build-up

- 1 Wooden formwork
- 2 Separating bitumen sheeting, nailed down for storm-proofing
- 3 FOAMGLAS® T4+, 100 mm, in hot bitumen
- 4 Hot bitumen casting
- 5 PC fixing plates (claw plates)
- 6 Single layer waterproofing, bituminous
- 7 Fleece separating layer
- 8 VM Zinc Quartz+ sheet metal covering





Metal roof systems

Summit Station Glacier 3000, Les Diablerets

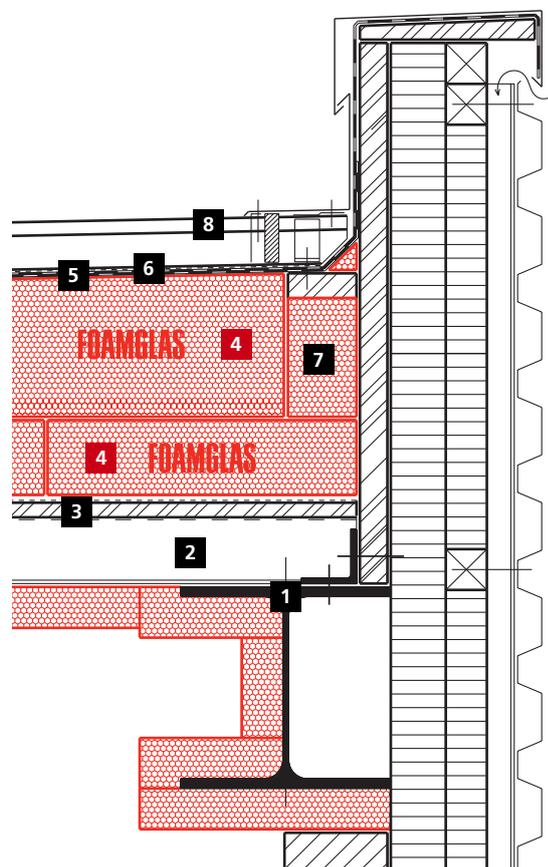
Architect Mario Botta, Lugano

Execution 2001

Use of FOAMGLAS® roof insulation, ca. 400 m², Type T4+, 2-lagig, Tapered Roof System (Flat roof with sloping pavement), mean thickness 320 mm, adhered, 571 COMPOSIT fastening element with wooden support

Covering of aluminium sheet metal, System KAL-ZIP

Safety from the floor to the roof. In order to satisfy the stringent requirements, roof, floor, exterior and interior walls are thermally insulated with FOAMGLAS® and at the same time safeguarded in terms of fire protection. The whole load-bearing structure of steel is fully sheathed in the safety insulation. The uppermost layer of roof insulation was installed with the FOAMGLAS® Tapered Roof System. This provided the desired falls and was covered with an Aluminium roof sheet.



Well insulated thermally and safeguarded against fire

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Build-up

- 1 Steel girders
- 2 Steel deck
- 3 Duripanel slab
- 4 FOAMGLAS® T4+, 320 mm, Tapered Roof System in hot bitumen
- 5 Two-layer bituminous waterproofing
- 6 Fleece separating layer
- 7 Composite fastening element
- 8 Sheet metal covering, Aluminium





**Swimming pool,
Compact Roof
system with
metal sheet**

Swimming Pool, Litomyšl – CZ

Architect DRNH architektonická kancelář, Ing. arch. Smejkal,
Ing. arch. Novák, Brno

Realisation 2009

Thermal insulation 900 m², FOAMGLAS® T4+, 2 x 150 mm

Surface finish Rheinzink Metal standing seam roof

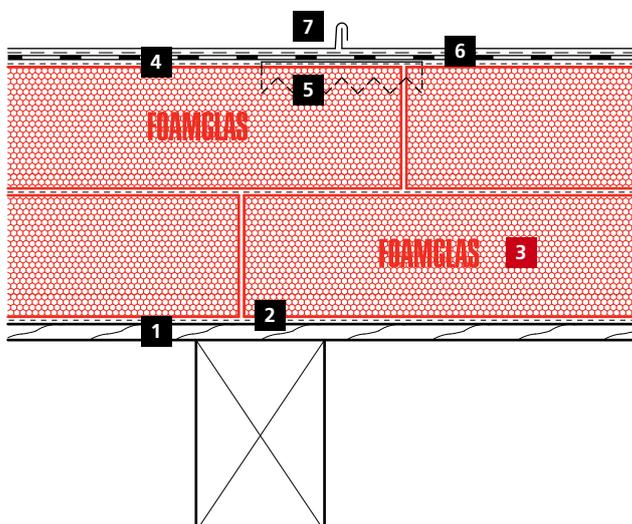
With an indoor swimming pool, the building physics requirements for the shell are often complex. Condensate in the building structure can normally only be prevented by ventilation, in the case of traditional insulating materials. This is not the case with FOAMGLAS®. Thanks to its physical structure, with millions of hermetically sealed glass cells, FOAMGLAS® is vapour tight

from end to end, and as a result forms the vapour barrier.

It is possible to install FOAMGLAS® without ventilation and removes the need for vapour control layers which are often easily damaged.

The FOAMGLAS® Compact Roof with metal standing seam is very universal and can be used on roofs with all types of structures, slopes and shapes.

**Flawless
building physics,
long-lived structure**
www.foamglas.com



Roof structure

- 1 Wooden structure and OSB board
- 2 Bituminous primer
- 3 FOAMGLAS® T4+ slabs, 2 x 150 mm, Compact Roof system in hot bitumen
- 4 Waterproofing membrane (1 layer)
- 5 PC® fixing plates, 15 x 15 cm
- 6 Separation layer
- 7 Metal sheet





Metal roof systems

Sport complex OLYMP in Yuzhny (UKRAINE)

Architect Yuri Seregin

Construction 2004

FOAMGLAS® application insulation of the standing seam roof with FOAMGLAS® READY BOARD 100 mm, 5200 m²

FOAMGLAS® insulation is outstandingly suitable for the building and insulating of metal roofs. Various system solutions guarantee that the monocoque unventilated roof in combination with metal sheet covering is one of the safest and technically advanced options. FOAMGLAS® is the only insulating material that takes over the assignment of thermal insulation & vapour barrier in a single function. In addition, the high compressive strength supplies the special argument that the fastening of the metal sheet roof takes places not in the load-bearing base, but through adhering in the insulation

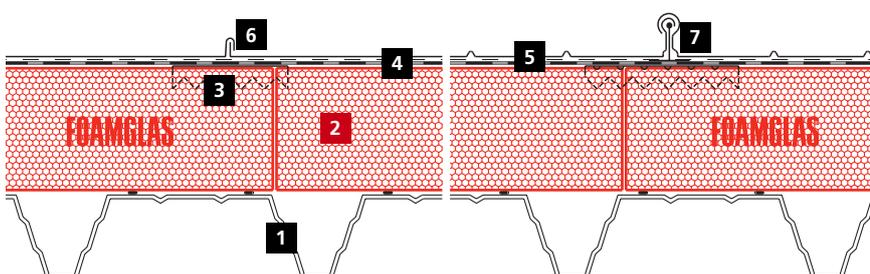
layer itself. It is therefore free of thermal bridges. The main arch made in the form of crescent-shaped trusses, has a span of 72 meters. Actually the project architects had been faced a difficult task – to design the light weight roof construction; which is able to withstand a rather strong wind and snow resistance in the same time. To solve this task, the FOAMGLAS® cellular glass insulation had been chosen.

Thermally optimized roof structure

www.foamglas.com

Build-up

- 1 Trapezoidal metal deck
- 2 FOAMGLAS® READY BOARD, bonded with PC® 11
- 3 Serrated fixing plate PC® SP 150/150
- 4 Bituminous waterproofing membrane
- 5 Separating layer
- 6 Standing seam metal sheet
- 7 Profiled metal sheet





Special roof systems

Centrum Bank, Vaduz (Principality of Liechtenstein)

Architect Prof. Hollein, Vienna/Bargetze + Partner, Vaduz, Principality of Liechtenstein

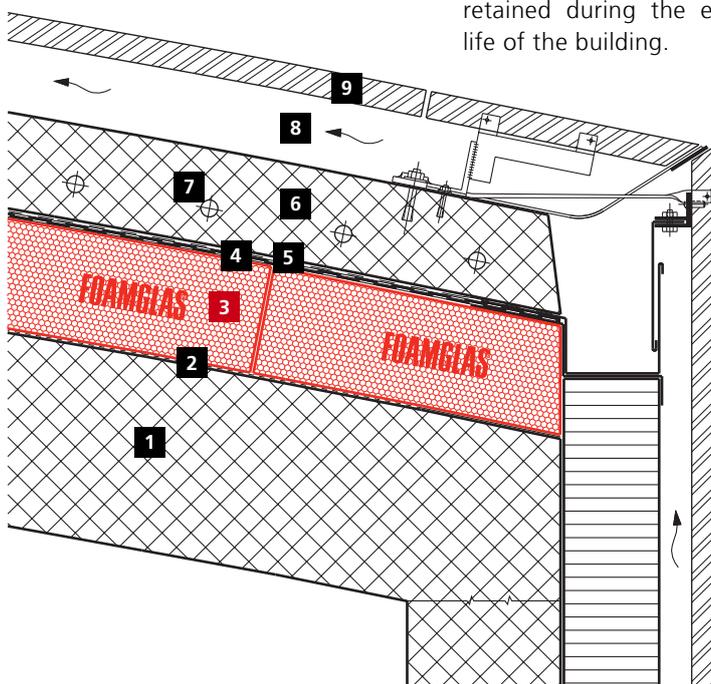
Execution 2002

Use of FOAMGLAS® roof insulation, ca. 500 m², Type T4+, thickness 160 mm, adhered

Covering of Andeer granite slabs

Banks place great value on roof structures that are stable in value, with a longer service life. Natural stone is an optimum covering material for this purpose. Covering that is high-ranking in terms of quality does not suffice, however, for guaranteeing a long service life expectancy for the whole struc-

ture. The layers underneath it, in particular the insulating material, must also fulfil this criterion. Due to its specific properties, FOAMGLAS® is extremely resistant to harmful effects of every kind, such as water penetrating over the joints. The quality and the value of the whole roof system are therefore retained during the entire operating life of the building.



Value retention and long service life through quality products

www.foamglas.com

Build-up

- 1 In-situ concrete in the fall
- 2 Bituminous primer
- 3 FOAMGLAS® T4+, 160 mm, in hot bitumen
- 4 Two-layer bituminous waterproofing
- 5 Fleece separating layer
- 6 Protective concrete/trass cement sealed
- 7 Heat recovery
- 8 Ventilation
- 9 Andeer granite slabs





Pitched Roof with Tiles Finishing

DEUSTO University, Bilbao Spain

Architects Pedro Feduchi & Cesar Sans Gironella

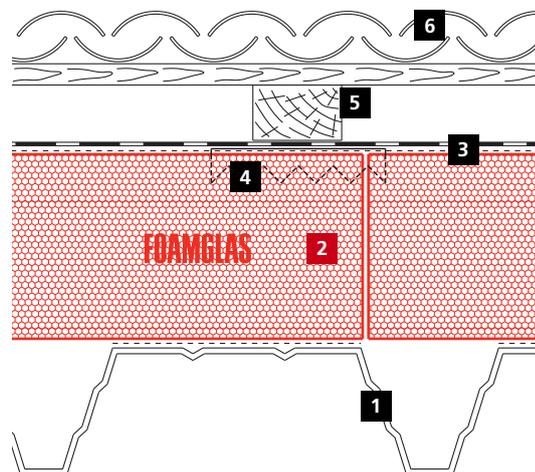
Application FOAMGLAS® READY BLOCK 70 mm on steel deck 2000 m²

Construction 2010

Finishing Tiles

In the early years of the XXth century Biscay needed new entrepreneurs and managers to lead the new banks, steel factories, shipping yard companies and other growing industries. The Project of "La Comercial" was undertaken by José María Bastera and Emiliano Amann with a neoclassical façade. Among their students we can find hundreds of individualities of the industry and finance. The refurbishment project by architect Pedro Feduchi and Cesar Sans Gironella during 2010 had as main purpose to keep the original. Close to it the Central building of Deusto is the older one, and it is known as "La Literaria". It was built following the project of Francisco de Cubas y González Montes, Marquis of Cubas and José María Bastera. In 2002 it was declared Historical Monument. To the east side of this Building the Centenary Building, under the Project of César Sans Gironella, includes the known as New Building and the Glass Building. On the other bank of the river Nervión was recently built the Deusto University Library – LCR (Learning

Resources Centre projected by Rafael Moneo and it is linked to the University by the Father Arupe Footbridge. In the Abandoibarra bank of the River several unique projects as the Guggenheim Museum, project by Frank Gehry, the new UPV Building by Álvaro Siza and Iberdrola Tower, projected by Richard Pelli, among other singular buildings define a hot architectural spot in Europe.



Sustainable Insulation System

www.foamglas.com

Build-up

- 1 Metal Deck
- 2 FOAMGLAS® T4+ slabs
70 mm, compact roof system
in hot bitumen
- 3 Waterproofing membrane
(1 layer)
- 4 PC® Metal plates 15 x 15 cm
- 5 Wood structure
- 6 Original Ceramic Tiles





Ventilated Roof Covering with "Canal" Tiles

Saint-Jean Church, Saint-Jean de Monts (85)

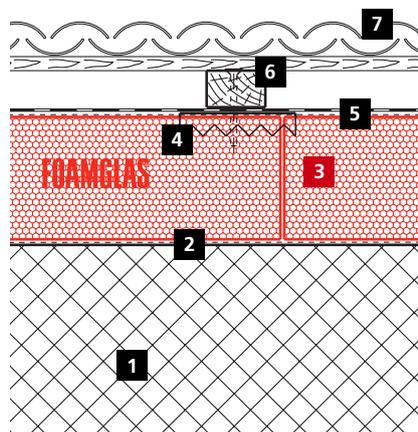
Owner Ville de Saint-Jean de Monts

Architect Seteb (85)

Constructor Michel Beneteau (49)

Year 2009

Whether the application is a standard pitched or low slope roof, a FOAMGLAS® Compact Roof ensures the integrity of both the insulation and waterproofing functions. FOAMGLAS® offers a modern solution to a traditional application and will maintain the design identity of the traditional aesthetics with tiles or slates. Its main features and benefits for the owner are un-rivaled: Impermeability to water penetration, preventing water tracking along its surface in low pitch design; Total resistance to water vapour that gives a constant thermal performance over the lifetime of the building; Air-tightness; Non-Combustible (Euroclass A1); Inert (is 100 % inorganic and cannot be attacked by insects, vermin, mould and rodents); Zero Cold bridges. The FOAMGLAS® warm roof build-up offers the building owner the perfect balance of performance and cost.



FOAMGLAS®,
Long-term guaranteed
moisture and thermal
protection
www.foamglas.com

Build-up

- 1 Concrete substrate
- 2 Glue
- 3 FOAMGLAS® T4+ (8 cm)
- 4 Serrated fixing plate PC® SP 150/150
- 5 Bituminous waterproofing membrane
- 6 Timber structure & substructure
- 7 Tiles





Ventilated Covering in Mountain Climate with "Lauze" Tiles

Swimming Pool Tignes (73)

Architect DHA (69)

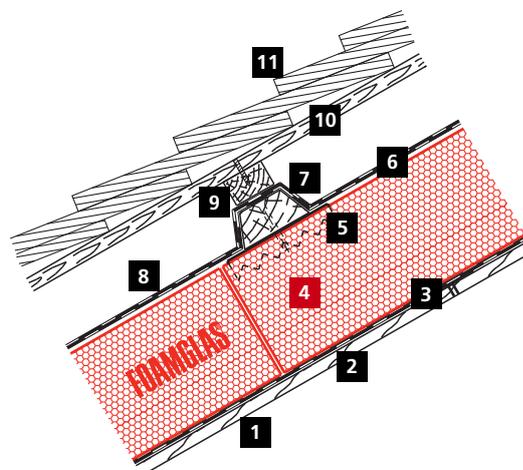
Owner Ville de Tignes

Constructor SN Jean Chedal (73)

Year 2005

For this particularly challenging project on a swimming pool roof in Tignes, France, the roof covering not only has to perform as a thermal element and waterproofing layer but also must withstand potential snow loads of 900 kg/m². The final choice of covering chosen by the client and architect was a "Lauze" Tile as this has superior performance in such conditions. FOAMGLAS[®] was also used in the design thanks to its high compressive strength and its ability to achieve continuous thermal protection, even in a such difficult environment. Whatever the roof design, (simple or complex), the FOAMGLAS[®] serrated metal plates when fully adhered to the FOAMGLAS[®] insulation and covered by a final waterproofing membrane, provide outstanding versatility (no through fixing and no thermal bridges). The absence of mechanical fastener provides both peace of mind and reliability.

It's a high performance system which meets all the required standards even under the arduous internal conditions of high temperature, very high humidity and chlorine vapour.



**FOAMGLAS[®],
Thermally optimised
roof structure**

www.foamglas.com

Build-up

- 1 Timber substrate
- 2 Separating layer nailed on or self-adhesive layer
- 3 Glue
- 4 FOAMGLAS[®] T4+ (12 cm)
- 5 Serrated fixing plate PC[®] SP 150/150
- 6 Waterproofing membrane
- 7 Trapezoidal length of wood
- 8 Waterproofing membrane
- 9 Timber structure & substructure
- 10 Timber support
- 11 Lauze tiles finishing





**Pitched roofs,
refurbishment
of three
19th century
buildings**

Byzantine and Christian Museum, Athens

Owner Hellenic Ministry of Culture

Architects Manos Perakis + Associates

Construction Refurbishment, 2009–2010

FOAMGLAS® application Insulation of pitched roofs, READY BOARD, 670 m², 50 mm thick; concrete roofs T4+ slabs, 260 m², 50 mm thick

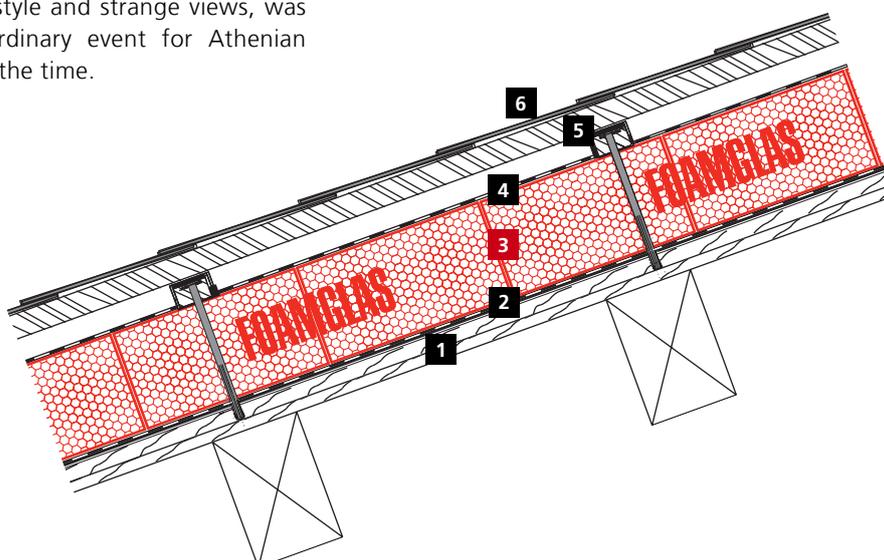
Roof finish Byzantine tiles

Villa Ilissia, which houses the Byzantine and Christian Museum, is one of the loveliest buildings erected in Athens during its early years as capital of the newly-founded Greek State. It was built as a main residence for the Duchess of Plaisance by the famous Greek architect of the time, Stamatis Kleanthis. The presence of a personality such as the Duchess, with a fascinating past, a formidable fortune, a singular life-style and strange views, was an extraordinary event for Athenian society of the time.

Around 1930 the palace was turned to a museum that would house the extremely valuable collections of Early Christian and Byzantine art.

The roofs of three 19th century buildings were refurbished in 2009 only, using FOAMGLAS® and Byzantine tiles as a finish. A first class choice and continuation in durability and perfection.

**Pitched roof system,
proven durability**
www.foamglas.com



Roof structure

- 1 Timber deck
- 2 Roofing sheet, nailed (basic protection during construction)
- 3 FOAMGLAS® READY BOARD
- 4 Waterproofing membrane
- 5 Support lathing and cross lathing
- 6 Byzantine tiles





Building physics and technology

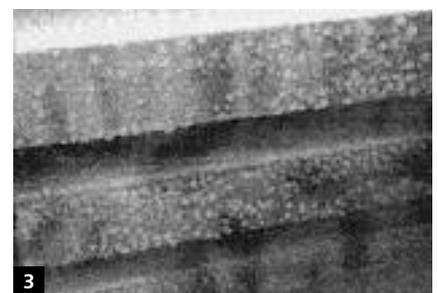
In the past people believed they could only solve condensation problems in metal roofs by virtually lifting the metal covering from the load-bearing and insulating structure. With FOAMGLAS® these problems can be eliminated safely and sustainably.

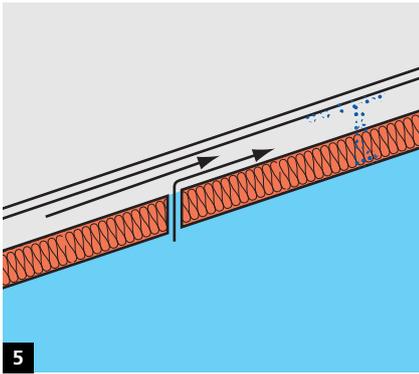
In principle a structure is free of condensate if:

- the thermal insulation value of the building component layers increases from the inside to the outside, i. e. the Lambda value becomes smaller
- the water vapour diffusion resistance of the building component layers decreases from the inside to the outside, i. e. the SD value becomes smaller.

At first glance, consideration of a structure with metal covering reveals that

- 1 Multi-family home, St. Gallen, Uginox FTE sheet metal covering using standing seam technique
- 2 Considerable amounts of condensation drip from the underside of the metal covering; the roof structure is subject to continuous moisture stresses. The fastening elements pierce through the sarking membrane.
- 3 Increased condensation formation underneath the metal covering. The cause: moisture-laden air current condenses on the "cold" surface.
- 4 "White rust" as a result of condensation formation on the underside of the zinc covering.





this principle is reversed here, because the metal layer, with the worst thermal insulation value and the highest water vapour diffusion resistance, is on the outside. This approach assumes the diffusion-proof nature of the metal covering that does not exist in reality.

Ventilated roofs of thin sheet metal

An air layer between the roof skin and the substructure diverts moisture that diffuses in over the inner building components, which are in the "right" order in terms of building physics.

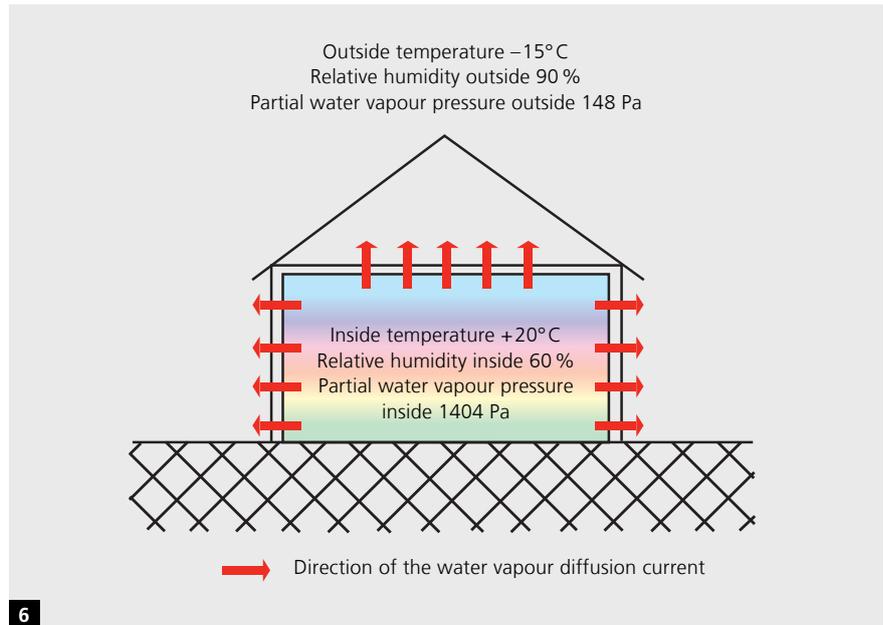
Basically this principle of the separation of functions is still correct. On the other hand there are also limits to use here, which are set by construction constraints or outside influences and can lead to a situation where a structure executed in this way is not protected against condensate loss in every case.

This double-shell ventilated structure does not "forgive" faults in execution at all. It does not cope well with leaking points in the substructure or indeed with missing diffusion barriers or damages.

Factors with an influence on the removal of moisture

The function of a ventilated metal covering, to remove moisture that diffuses in, is dependent on various factors.

■ The moisture that diffuses into the structure with ventilation pres-



ent and functioning must also be kept to a small amount through appropriate construction measures.

■ The air conduction in the structure must be designed in such a way as to guarantee the most continuous possible flow of air.

To reduce the amounts of moisture diffusing into the structure, the build-up of layers underneath the air layer must be carried out in such a way that sufficient resistance is put up against the diffusion pressure. Therefore in lightweight structures a so-called vapour seal is incorporated underneath the insulation, usually in the form of a plastic film. In theory this eliminates the problems.

Ventilation not without problems

However, problems often arise in the area where the membranes overlap and above all in the wall joints, places where the roof is pierced, etc. Due to joints that are not sufficiently closed, room air streams into the structure as a result of pressure differences. The amount of water vapour penetrating amounts to a multiple of what could be introduced through diffusion. The large amount of water vapour can no longer be removed quickly enough; saturation of the air flow occurs, with the result of condensation and water

- 5 **Vapour diffusion processes**
Direction of the water vapour diffusion current with temperature gradients from inside to outside. Is there really diffusion impermeability?
- 6 Suction effect through the ventilation with open joints in the vapour seal.

ingress into the insulation. The consequences are energy losses due to the room air flowing out and through the decrease in the insulating capacity as a result of condensation formation – to say nothing of the probable damages in the structure.

Attention must therefore be given to the air and wind impermeability of the vapour barrier connections, also and specifically with ventilated structures.

Air current

For removing small amounts of moisture diffusing into the ventilation space, the most continuous possible air flow is necessary. The velocity of the ventilation current is primarily dependent on two factors:

- the ventilation path
- the ventilation height (slope)

Ideally the best thermal relationships arise in an air layer that is as steep as possible, because the ratio of height to air path length is the most favourable.

Openings for intake and outflow

The position and shape of the openings for intake and outflow must also be given great attention. The openings

should be executed as slits that pass through and must be of a sufficient size.

The thermal relations are determined by the temperature difference with the outside air.

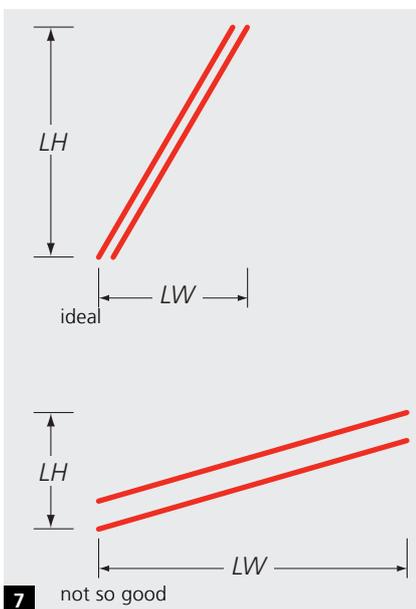
The insulation values required today due to the thermal protection regulations minimise the passage of heat so that the warming of the air layer due to heat passing from the inside of the building which is necessary for the thermal relations can hardly take place.

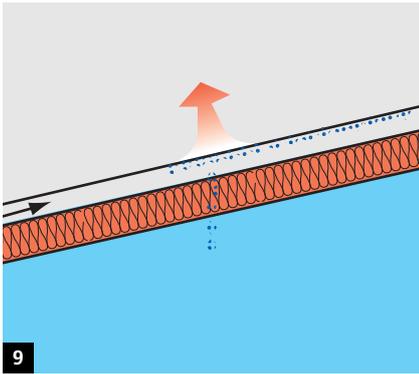
Problem of secondary condensation

Conversely, under some circumstances there is even the danger that at low temperatures with high humidity – frost and freeze/thaw – the outside air penetrating into the ventilation space will also form water or hoarfrost on the underside of the roof surface and in this way moisture will be brought into the structure, so-called secondary condensation.

These points alone already make it clear that a ventilated structure is not always without risks. If a few imperfections or faults come together in the shaping of the shifted air layer, it can

- 7 Ventilation path and height
- 8 Multi-family houses, Zurich, compact roof with sheet metal covering – roof inclination too small for functional ventilation





result in condensation dripping off into the building components, resulting in damage to the substructure.

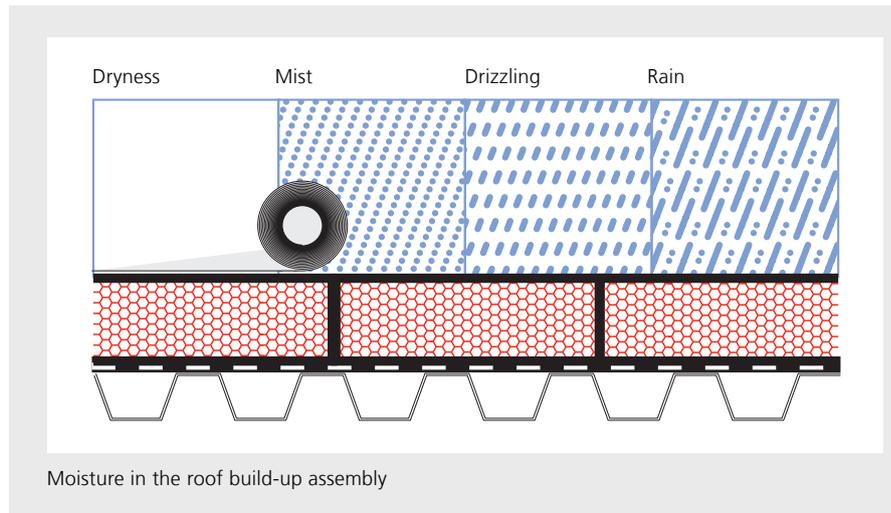
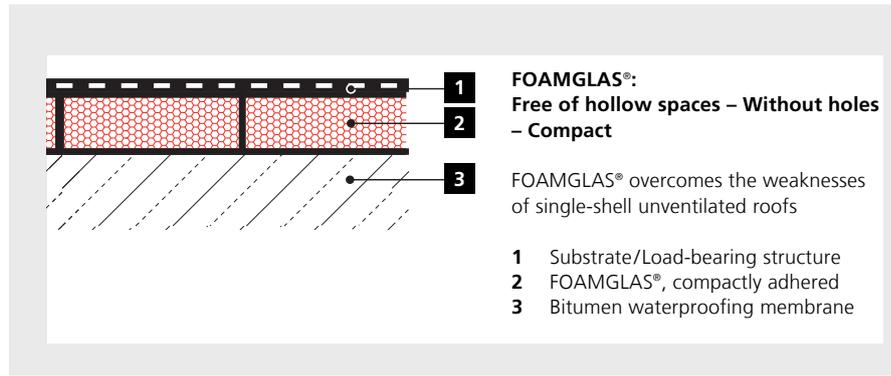
Unventilated roofs of thin sheet metal

For a long time metal roofs have been executed as a monocoque (single shell), if this is necessary for design reasons and if the conditions do not allow ventilation, for example in large, flat sloping roofs.

Since this construction principle offers a great many advantages when executed properly, in the future it will be accepted more and more.

New, advantageous possibilities

In particular the differentiated roof geometries of modern architecture, high demands for thermal protection and the development of innovative sheet metal roof systems, such as e.g. the FOAMGLAS® compact roof with sheet metal covering, lead to the expectation of a further development in the direction of the unventilated roof. In addition there is the fact that processors are increasingly becoming familiar with this technique, supported not least by the specialist rules for monocoque unventilated metal coverings. If the diffusing of moisture into the structure is ruled out by the incorporation of a vapour barrier or a vapour-proof insulation like glass foam on the inner side of the structure, continuous ventilation of the metal covering is no longer necessary. **Where there is no moisture, none must be removed.** The height of the roof build-up is



reduced through this; openings for air intake and outflow, which are costly in money and construction time, are eliminated; and the designer has greater freedom of design. Not least, the work is simpler for the metal roofing contractor, and risks such as rain or snow entering through ventilation openings are excluded.

The ability of a monocoque metal roof system to operate depends essentially on whether moisture is brought into the roof structure. In principle moisture can penetrate into the roof in three ways:

1. Leaking of rain in the upper deck shell
2. Building moisture during the assembly phase
3. Condensation as a result of water vapour diffusion/condensate as a result of moisture transport through air currents through leaks in the roof structure

On point 1 and 2: An important con-

- 9 Secondary condensation. Outside air streaming in condenses on the underside of the roofing.

dition for a warm roof free of damage consists in no moisture being incorporated between air-seal layer and the bituminous membrane and in the insulation not getting wet during the installation phase. If there is unwanted moisture between the two sealing layers (vapour seal and bituminous membrane) there is a danger that the structure will be damaged because drying out takes place slowly. Incorporated building moisture, in addition, increases the building physics load on the bituminous membrane and can lead to condensate dripping off and incrustation of fouling matter from micro-organisms on the underside.

On point 3: As with a ventilated structure as well, the execution of the wind, air and water-proof vapour barrier has crucial significance for the ability of the monocoque structure to function. A vapour barrier is always required with traditional systems, even with substructures with high diffusion resistance like concrete.

The wind and water-proof execution of the butt joints and edge joints also has decisive significance here. Roof edges, eaves, verges and roof penetrations require extreme care in execution. The effects of open joints and edge joints cause problems similar to those with the double-shell ventilated execution.

**FOAMGLAS®:
a guarantee of safety**

As a compression resistant, vapour and water-proof insulation, FOAMGLAS® offers product-specific plus points and unambiguous answers to critical questions concerning unventilated metal roofs.

Thermal insulation and vapour barrier. No water can accumulate in the closed cellular structure. FOAMGLAS® is insulating layer, vapour barrier and load-bearing deck substrate for the metal roof "in one". In the compact installation procedure, the insulating layer blocks the diffusion and air current in all directions – and not only as a limited thin layer vapour barrier.

Through the butt joint adhering of the FOAMGLAS® slabs, the insulating layer in the installed system is resistant against vapour diffusion and has airtight joints.

In the case of roof structures with FOAMGLAS® the question does not arise as to whether – e. g. with ventilation layer or actively breathing, costly intermediate layers – the accumulated moisture can be removed. Or as to whether as a result of labour-intensively executed vapour/air barrier the warm roof principle also actually works.

FOAMGLAS® prevents the passage of moisture in the form of water or water vapour. The dew point lies in the closed cellular insulation layer. Due to this the FOAMGLAS®-insulation layer remains uncritical and indestructible in terms of building physics.

For the most stringent requirements

Dew point displacement through water accumulation in the insulating materials or deterioration of the thermal insulating properties cannot take place with FOAMGLAS®. In addition the high degree of compression resistance provides the special argument that the fastening of the metal roof covering takes place not in the load-bearing backing – and therefore encumbered with thermal bridges – but rather through adhering in the insulation layer itself.

With other roof structures with a separate vapour barrier, on the other hand, the vapour sealing layer is interrupted or perforated. Condensate in the insulation layer and corrosion of the fasteners are then as much to be feared as thermal bridges.

- 10** How securely can air barriers and vapour barriers be connected to the edge of the roof?
- 11** Clear formation of folds in the air and vapour barrier. The result: air streaming through carries moisture into the insulation layer package.

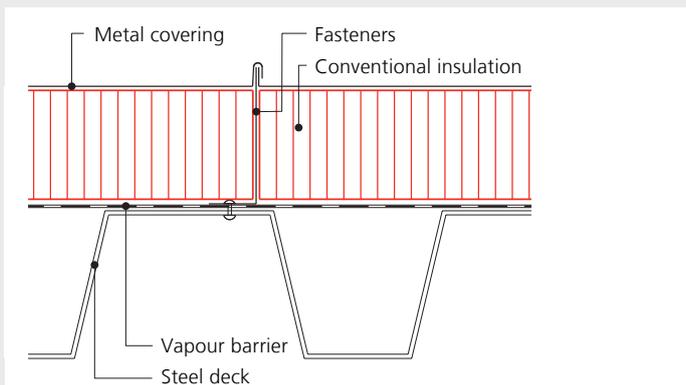


The use of FOAMGLAS® leads to a warm roof structure that corresponds to the highest performance requirements in terms of thermal technology and building physics, and in addition can be built using suitable craftsmanship procedures.

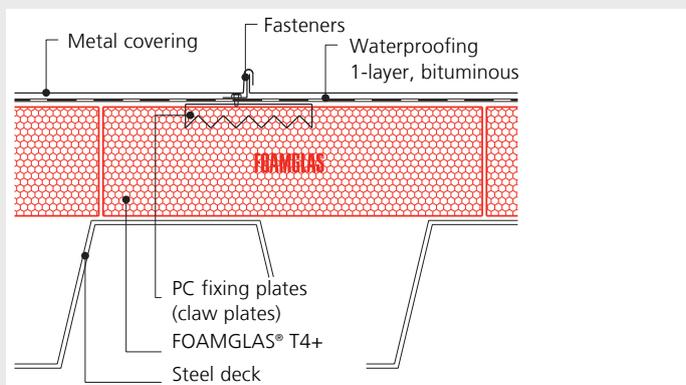
Hardly any thermal bridges or heat losses with FOAMGLAS®

In the traditional warm roof, e.g. with mineral fibres or plastic foam, mechanical connectors must be anchored through the insulation layer into the load-bearing substrate. Depending on the way the inside space is used and on the humidity, there are risks of corrosion and condensation formation, in particular with low outdoor temperatures.

If for example a conventional sheet metal roof system with mineral wool insulation slabs of compression-resistant quality, in combination with the penetrating fasteners typical for the system, is compared with the FOAMGLAS®-compact roof with sheet metal covering, a decreased insulation thickness in favour of FOAMGLAS® is revealed. The reason: FOAMGLAS® insulation structures do not require any mechanical fasteners that penetrate to take up the covering. Heat losses due to thermal bridges are also correspondingly minimised.



In the warm roof with e.g. mineral fibres or rigid plastic foam, fastening is done mechanically between the metal covering and the load-bearing shell. The result: thermal bridges! In addition there is the question: How secure is the vapour/air barrier?



FOAMGLAS® insulation structures do not require any mechanically penetrating fastening devices to take up the covering. The sheet metal covering is assembled with "claw plates" (PC® fixing plates).



- 1 Fire spreading over facade and roof is often the cause of devastating total damages.
- 2 Sheet metal roofs create special requirements in the event of fire.

Passive fire protection

After fires, heated discussions are often ignited about responsibility and protection against fires. Here the question of insulation materials also often plays a central role. Scientific investigations clearly show: FOAMGLAS® can contribute conclusively to passive fire protection. The safety insulation is not only absolutely non-combustible, but also develops no black smoke or toxic gases.

Prevention begins with the choice of materials:

“Fire disaster”, “Indications that there were infringements against the fire protection regulations”, “Swift spread of the fire favoured”, “Flaming Inferno”. Headlines of this kind make it clear: Precisely in the roof area – perhaps in spite of legally fulfilled fire protection conditions – building fires can only be extinguished with difficulty.



It is all the more important to pay attention to prevention. Through the choice of suitable building materials and roof systems the risk of a fire breaking out, above all also of the fire spreading through hollow spaces and through combustible materials, can be significantly lessened. FOAMGLAS®, the safety insulation of glass foam, and the compact roof system free of hollow spaces, have already done this in many cases.

Smouldering fires as a special hazard

Fires of this kind primarily spread inside building components and therefore often remain unnoticed for a long time. Sometimes hours can pass between the hidden fire and the breakout of the open fire. The physical and chemical

properties of insulating materials many hold the danger of such smouldering fires: air (oxygen) can stream through the building material, even though not completely unhindered. **Not so with FOAMGLAS®: The closed cell structure of the glass foam insulation prevents this.**

Prefabricated metal roof insulating elements of rigid foam with timber structure: And how does it look with metal roof insulating elements – of rigid foam, with inlaid timber structures – for warm roof structures?

Rigid foam insulating materials, e. g. polystyrene or polyurethane, are combustible. While the fire processes drip off material residues, which likewise burn. Especially in the area of public buildings, in connection with rooms

Fire brigade reports in practice:

“... metal roofs make attacking extinguishing through the fire escape more difficult. It is almost impossible to bring water from above into the building, since the roof, to the extent that it does not cave in, remains sealed even with great heat. In this case it is urgent that openings be made. This could only be done with heavy construction machinery. Through the structure of the roof (hollow space) the fire was able to extend over the whole building ...”

“... Since targeted extinguishing with water was not possible through the sheet metal roof, the fire service used a thermal imaging camera and high expansion foam generator. By recognising the source of fire by means of the camera, targeted extinguishing was enabled and post-ignition through flooding of the roof area with the high expansion foam generator was averted ...”



that are used for gathering purposes, in office complexes as well as in buildings of the catering trade, the use of combustible material has to be ruled out.

FOAMGLAS®: Neither thick smoke nor poisonous gases

It does not always have to be a “flaming hell” when fire disasters are spoken of. One is reminded for instance of the disasters of the Düsseldorf airport (1995) with 17 victims or the Montblanc Tunnel (1999), in which 39 people lost their lives. In both cases toxic gases from insulation that was technologically problematic in terms of fire (Düsseldorf polystyrene, Montblanc polyurethane) played a deadly role.

FOAMGLAS® however, develops neither thick smoke nor toxic gases. In matters of fire protection FOAMGLAS® is not comparable with any other so-called “non-combustible” insulation. The difference results also from the fact that FOAMGLAS® does not smoulder in the event of fire, and consequently does not cause any passing on of the fire.

FOAMGLAS® melting point > 1000 °C

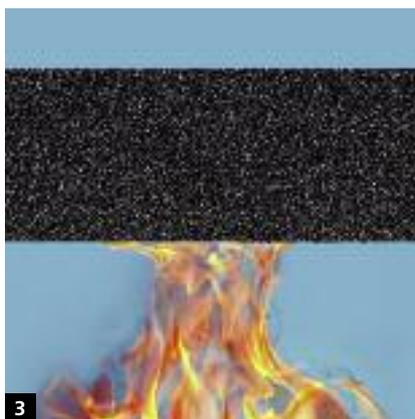
According to German DIN 4102-17 the melting point of FOAMGLAS® was tested at MPA Braunschweig Institute (D). More than 50 % of the insulation thickness lasted the 90 minute fire period without significant damage. As an official result the melting point is >1000 °C.

General protection with FOAMGLAS® in case of fire: Melt Shield-Effect

Comparable as a thermal protection shield the melted glass surface of the flame treated area is protecting the lower cell structure. The temperature on bearing structure is remaining low. FOAMGLAS® is defending the building structure in case of fire.

FOAMGLAS® provides real preventive fire protection

- FOAMGLAS® safety insulation consists of pure foamed glass and is absolutely non-combustible (Combustibility class A, Fire index no. 6.3, not combustible, approved by the VFK with TA No. 5273).
- Due to the closed cell structure of FOAMGLAS® no fire-fuelling oxygen can reach the source of the fire.
- FOAMGLAS® is vapour tight. The passage of hot conflagration gases or their propagation in the insulation is excluded. The safety insulation prevents the spreading of fire.



- 3 No propagation of flames in the event of fire. FOAMGLAS® is absolutely non-combustible
- 4 Conclusion after test procedure: FOAMGLAS® melting point > 1000 °C.
- 5 Experimental setup for testing the melting point of FOAMGLAS®.



Excellent Ecological profile

FOAMGLAS® insulation systems are stable under all conditions of use and protects the owner from unexpected expenditures for heating or expensive replacement of the insulation or repair. FOAMGLAS® systems safeguard the environment one way or another. They allow for energy saving and, from the cradle to the grave, they do not contribute to environmental pollution, a safe product consistent with the principles of building physics. Cellular glass is certified to standards of health and indoor air quality. Ecologically viable product recycling is possible in the case of building demolition.

Typically 60%+ of the raw material is recycled glass. A very low percentage of carbon is added during manufacturing which makes the charcoal grey color of the insulation. In the cellulating furnace the soft, viscous glass is foamed through release of carbon dioxide (CO₂) and forms millions of airtight glass cells enclosing the gas. This closed cell glass structure ensures full resistance to the transmission of vapor (resistance to water vapor transmission $\mu = \infty$).

Production and composition

FOAMGLAS® manufacturing is two sub-processes. In the first part of the process the recycled glass is melted and subsequently batched with the remaining raw materials and crushed in a mill. In the second sub-process the powder mix passes in the cellulating furnace at high temperature where FOAMGLAS® cellular glass is foamed – comparable to the process of fermentation in bread baking.

- 1 Renewable energy sources are increasingly used in FOAMGLAS® production.
- 2 FOAMGLAS®: millions of airtight glass cells



Environmentally friendly production

The raw materials used in the FOAMGLAS® production are inherently mineral and thus environmentally friendly. Principal raw material is recycled glass. Further raw materials are feldspar, sodium carbonate, iron oxide, manganese oxide, carbon, sodium sulfate and sodium nitrate. By the introduction of recycled glass into the production FOAMGLAS® makes a relevant contribution to the protection of the environment.

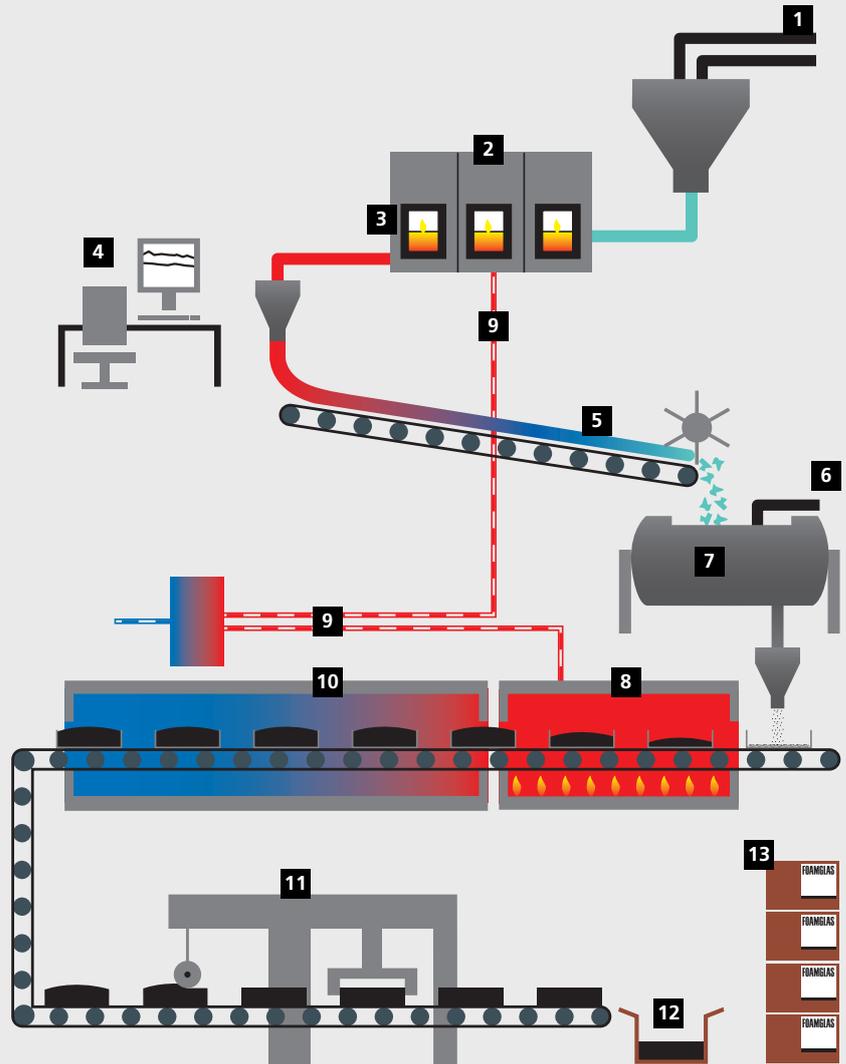
Minimal environmental pollution

Due to improvements in process engineering and in the energy supply (coming from hydro electric energy and wind turbines) significant progresses has been achieved in recent years regarding air pollution, greenhouse gas emissions, consumption of energy and resources:

- The demand for non-renewable energy was reduced 4.24 kWh/kg.
- Greenhouse gas emissions have been halved.
- The percentage of recycled glass was progressively increased from 0 % to 30 and to 60 %.
- The environmental pollution score (UBP97) was reduced from 1619 to 743 points.
- The eco-indicator (EI99 H, A) dropped from 0.13 to 0.09 points.

Reduction of the production energy means that the time period for energy amortization of the investment in thermal insulation – as an important evaluation unit – is considerably reduced.

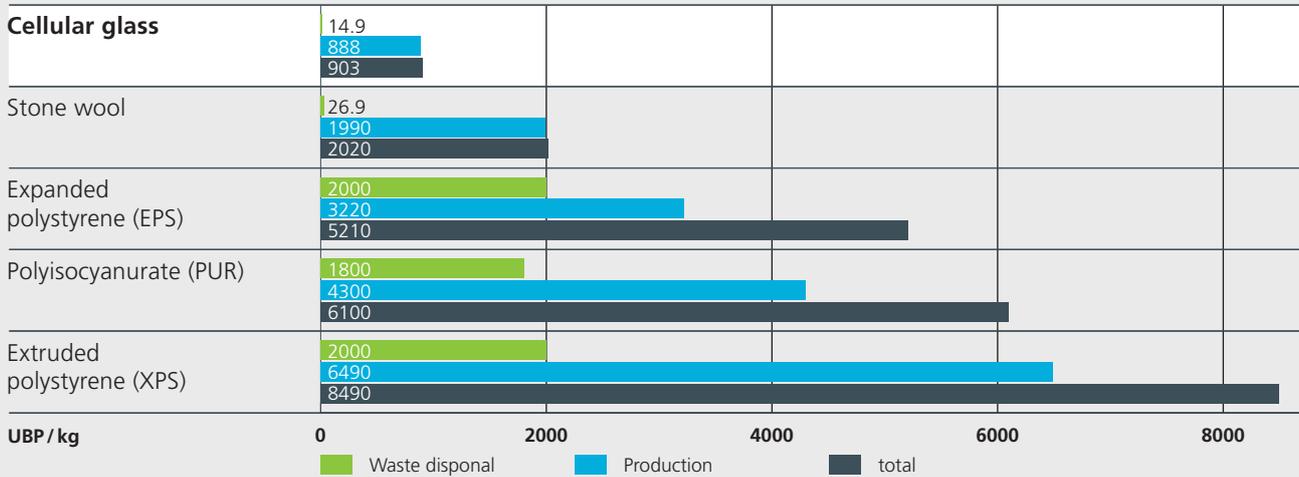
FOAMGLAS® manufacturing (Tessenderlo Plant, Belgium)



- 1 Mixing and batching of the raw materials: Recycled glass, feldspar, sodium carbonate, iron oxide, manganese oxide, sodium sulphate, sodium nitrate.
- 2 The melting furnace has a constant temperature of 1250°C.
- 3 Molten glass is drawn out of the furnace.
- 4 Control room for monitoring the production.
- 5 The glass is drawn off and falls onto the conveyor band where it cools down before entering into the ball mill.
- 6 Addition of "carbon black".
- 7 Ball mill grinds all ingredients into a fine powder before putting into stainless steel moulds.
- 8 The filled moulds pass through a cellulating oven (Foaming furnace) with a temperature of 850°C. This is where the material gains its unique cell structure.
- 9 Energy recovery of heat.
- 10 The FOAMGLAS® blocks pass through an annealing oven to allow carefully controlled cooling of them without thermal stress.
- 11 The blocks are cut to size and sorted by batch. Production waste is recycled.
- 12 FOAMGLAS® slabs are then packaged, labelled and palletized.
- 13 Finished FOAMGLAS® products are stored and prepared for transport.

FOAMGLAS® stands comparison

The environmental pollution score (UBP 2006**) for the production and waste disposal of FOAMGLAS® is 903 points/kg (insulation). This puts FOAMGLAS® into the pole position in eco-balance. Other insulation products show points between 2020 (stone wool) and 8490 (Extruded polystyrene).



Compared to surfaces, with a specified insulation value of 0,20 W/m²K, FOAMGLAS® performs very well. The environmental pollution score (UBP 2006**) of cellular glass is 17 157 points (FOAMGLAS® W+F), 21 807 points (FOAMGLAS® T4+) per square meter. Other insulation products show 23 790 points (PUR), 26 571 points (EPS), 46 056 points (stone wool) and 53 232 points (XPS) for an identical U-value (see table).



Insulation	ρ	λ _D *	d	weight per m ²	UBP* per kg	UBP per m ²
	kg/m ³	W/mK	m	kg/m ²	UBP/kg	UBP/m ²
FOAMGLAS® T4+	115	0.041	0.21	24.15	903	~ 21 807
FOAMGLAS® W+F	100	0.038	0.19	19.00	903	~ 17 157
Polyisocyanurate (PUR)	30	0.026	0.13	3.90	6100	~ 23 790
Stone wool	120	0.038	0.19	22.80	2020	~ 46 056
Expanded polystyrene (EPS)	30	0.034	0.17	5.10	5210	~ 26 571
Extruded polystyrene (XPS)	33	0.038	0.19	6.27	8490	~ 53 232

* The data are taken from building database KBOB/EMPA, June 2009.

** The environmental pollution score (UBP 2006) quantifies the pollution coming from resources, water consumption, emissions into air, water and ground and also for the waste disposal. The environment pollution through grey energy and global warming are included in the UBP score.

World resources

The principal raw material of FOAMGLAS® production today is selected recycled glass (in the past the main raw material was silica sand). The supplies of recycled glass are ample, as in the construction and other industries large quantities amass and have to be disposed of as waste. Plastic foam insulation, however, is produced from crude oil, which is a non renewable fossil fuel.

FOAMGLAS® cellular glass insulation products now with natureplus label

Natureplus, an international organisation for the development of a culture of sustainability within the building sector, has selected cellular glass thermal insulation from Pittsburgh Corning Europe SA as a green building product and awarded the natureplus quality label. "Cellular glass thermal insulation by Pittsburgh Corning Europe SA ideally meets the quality requirements for a sustainable construction product", noted Uwe Welteke-Fabricius, president of natureplus e.V., when handing-in the certificate. The natureplus quality seal is the symbol of recognition for building products with a high level of quality in the areas of health, the environment and functionality. Pittsburgh Corning's FOAMGLAS® types W+F, T4+, S3 and F from the Tessenderlo plant (Belgium) are tested and certified successfully.

Service life

Having outstanding qualities (mineral, impermeable to water and vapor, resistant to acids, non-combustible, high-temperature resistant), cellular glass is a very durable material. The long service life of the material has very positive effects, ecologically and financially, on the service-life of the construction and, consequently, on the life of the building. Maintenance and replacement cycles can significantly be reduced by the use of durable materials.

Emissions / nuisance during installation and use

Cellular glass does not release harmful or toxic components into the environment. It does not contain green house gases or ozone depleting products, no flame retardant and no con-taminative or carcinogenic particles and fibers. When recommended installation instructions are followed, cellular glass insulation does not produce emissions that degrade the environment or health, at production, installation nor use.

Emissions in case of fire

Dumping and burning of construction waste is most critical for the environment, even in small quantities. In particular plastic foam materials are classified as harmful. In the case of burning of these materials high levels dangerous emissions are released than in combustion in an incineration plant. Studies have been conducted in Germany on

thermal combustion of polystyrene insulation, which clearly indicated that released fumes are acutely toxic. Serious adverse health effects in the long-term cannot be excluded. Even with combustion in a waste incineration plant, there is high impact to the environment, as annually several thousand tons of slag and filter residue have to be transported to special disposal sites. The non-combustibility of cellular glass makes the toxicity issues irrelevant.



natureplus – The European quality seal for approved green building products.

Ecological assessment for different thermal Insulation materials.

	Production energy	Resources	Nuisance for workers	Emissions during production	Emissions in case of fire	Long-term performance	Disposal / Recycling
Glass wool	Yellow	Yellow	Orange	Yellow	Yellow	Orange	Orange
Stone wool	Yellow	Yellow	Orange	Yellow	Yellow	Orange	Orange
Cellulose insulation	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Yellow
Pure expanded cork	Yellow	Red	Yellow	Yellow	Orange	Orange	Yellow
Expanded polystyrene	Orange	Red	Yellow	Yellow	Orange	Orange	Orange
Extruded polystyrene	Orange	Red	Orange	Yellow	Orange	Yellow	Red
Polyurethane (PUR)	Orange	Red	Orange	Yellow	Red	Orange	Red
FOAMGLAS®	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

Very good
Acceptable
Critical
Very critical

Positive ecological assessment for FOAMGLAS®: Source: Cellular glass insulation, a cost-effective and environmentally sustainable solution. [Schaumglas-Dammstoff, Wirtschaftlich und umweltverträglich Dämmen.] Markus Welter, Lucerne

Waste disposal

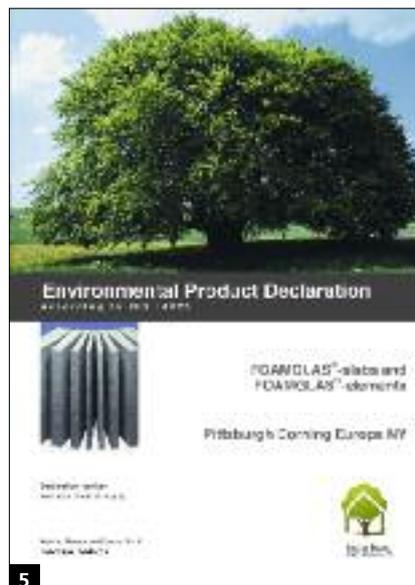
In the assessment of insulation materials one consideration is repercussions on the environment from waste disposal. There are significant differences between the various insulation products. In total evaluation – and considering the scarcity of raw materials – as documented in eco-balance data sheets for the building industry, plastic foam insulation receives poor ratings for environmental pollution.

Recycling

Cellular glass being non-combustible, combustion in a waste incineration plant is not a possibility. An option is the recycling of cellular glass as crushed stone (for bedding in road construction) or infill material for noise barriers. Recycled FOAMGLAS® is a safe and suitable product for these applications, as it is dimensionally stable, neutral for the environment, inorganic, rot-proof and without any risks for the ground water (meets ELUAT-test requirements). If crushed and recycled FOAMGLAS® is not used as bedding or infill material, it can be taken to an inert waste disposal site, like crushed concrete or brick.

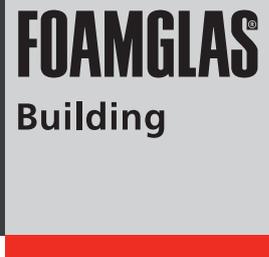
FOAMGLAS® – a valuable contribution to the protection of the environment.

- Today FOAMGLAS® is made from 60 %+ recycled glass. The FOAMGLAS® manufacturing concept is waste reduction and green energy utilisation.
- For the FOAMGLAS® production only energy from renewable sources is used.
- Environmental pollution during manufacturing has halved when compared to 1995.
- FOAMGLAS® insulation meets all environmental and health requirements for construction products.
- At the end of its service-life FOAMGLAS® disposal is simple. One option is the use of recycled cellular glass as infill in trenches or back-up for buried pipes.
- FOAMGLAS® has an outstanding service-life, which is clearly the best for the environment.
- On balance: FOAMGLAS® is an insulation concept fit for the future that gives an answer to the genuine concerns for the environment. The system ensures that all demands on performance, durability, environmental integrity and sustainability are fulfilled.



- 3 The percentage of recycling glass in the FOAMGLAS® production is from 30 to 60 %.
- 4 Crushed FOAMGLAS® – a recycled filler material for trenches.
- 5 FOAMGLAS® Environmental product declaration (according to ISO 14025) confirms the sustainable and ecological value of FOAMGLAS®.

www.foamglas.com



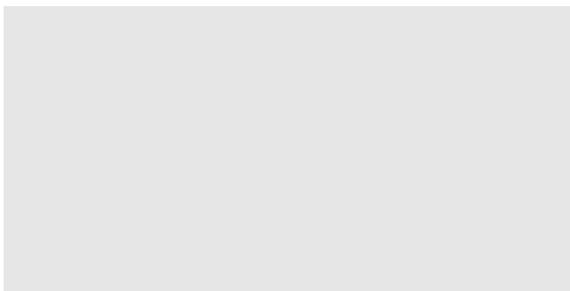
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ELUAT – elution test. FOAMGLAS® meets the requirements of ELUAT test (Investigative report EMPA Nr. 123544 A, based on the successful testing of bitumen coated FOAMGLAS® specimens). According to declaration scheme D.093.09 of the Swiss Technical Directive for Waste Management [Technischen Verordnung über das Abfallwesen (TVA)], FOAMGLAS® is an authorised material for inert waste disposal sites.

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www.foamglas.com



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