



# INVERTED FLAT ROOFS

Instructions for installation  
of FIBRANxps thermal insulation boards



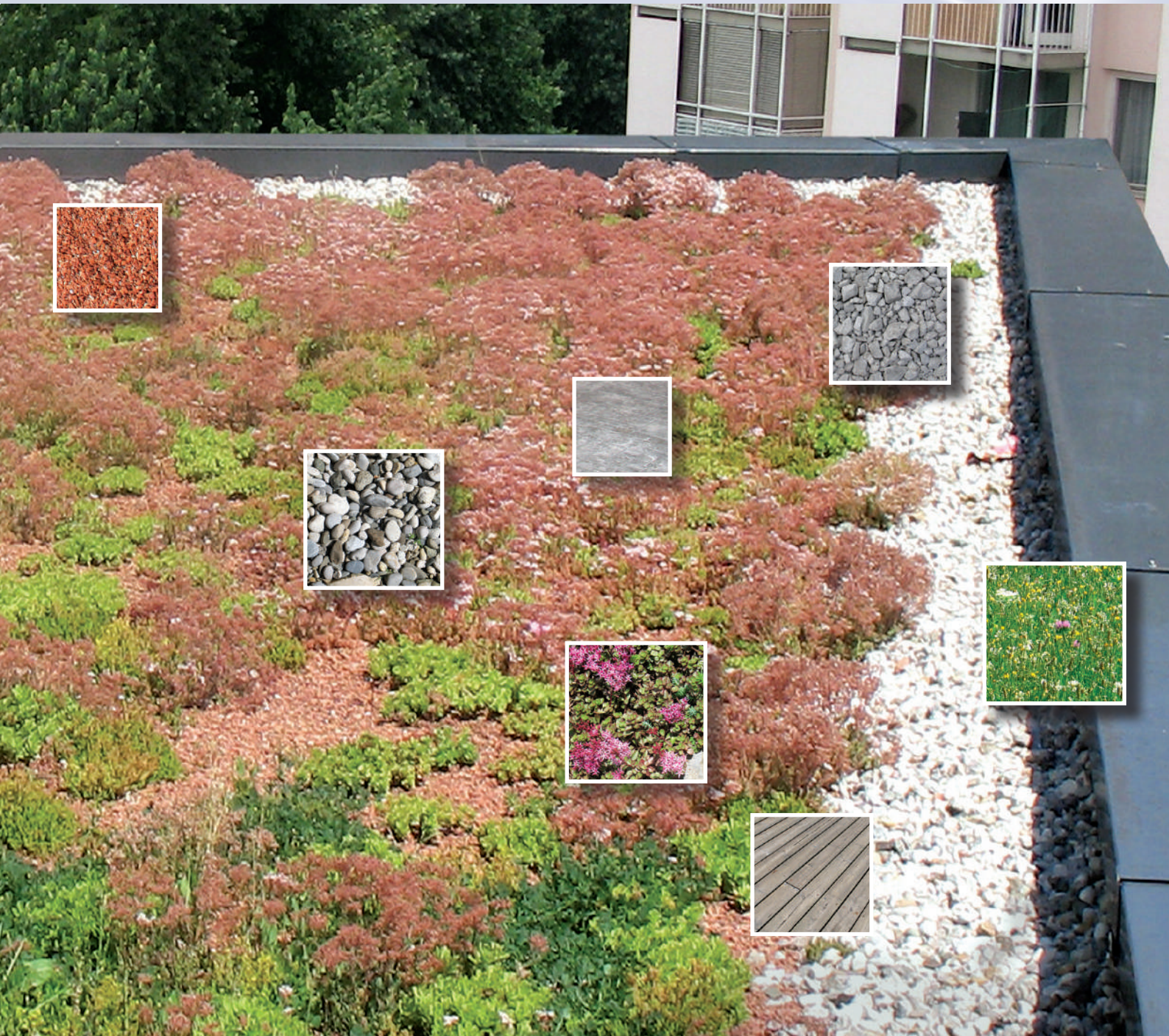
# Inverted roof

## Advantages of inverted roofs

Roofs have long since been not only a protection against atmospheric influences – they are also an important aesthetic and functional part of buildings. As attics can be alluring in a special way, so can tempting flat surfaces under the open sky, which can be usefully arranged for leisure and recreational activities. They can also be used as parking areas and one can even arrange a real garden amidst the city. They can be very useful additional surfaces, regardless of our decision, though not always.

**The total surface area of a flat roof can be used entirely by constructing an inverted flat roof.**

**An inverted roof is a revolutionary discovery** providing investors with a chance to gain additional useful surface at no extra cost, thus increasing the building's value. The added value is two-fold. Apart from the additional useful surface in the form of a garden, terrace or roof parking lot, the inverted roof principle guarantees a several times longer lifespan for the hydroinsulation membrane thus increasing the durability of the entire roof. The inverted roof requires thermal insulation in which abilities for thermal insulation are preserved even under the influence of humidity. Compact thermal insulation from foamed extruded polystyrene (XPS) is used in inverted roof systems. With a closed cell structure such systems provide flawless thermal protection even in humid conditions.



**1. The roof's durability:**

The roof's durability is assured by a thermally, mechanically and UV protected waterproofing membrane.

**2. Permanent thermal protection:** Thermal insulation made of extruded polystyrene (XPS) protects the building from cold and heat, even in humid environments.

**3. Surface use:**

FIBRANxps is a rigid thermal insulation, enabling the surface to be used as a walk-on or driving surface.

**4. Simple installation and maintenance:** The inverted roof is mounted with prefabricated components, therefore the modifications in its composition are quite simple.

**5. Repairs:** Damage location or potential mistakes at waterproofing layer installation are detected quickly and can easily be repaired.

**6. Environment:**

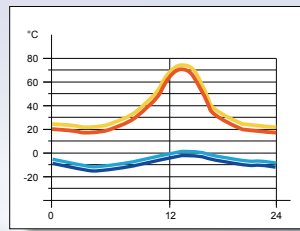
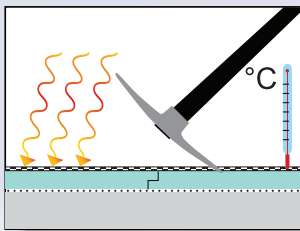
Roofs with gravel, timber decking and especially green inverted roofs add a piece of nature to the city's concrete jungle.

**7. Price:** Quick and easy installation of inverted roofs, the possibility of surface use, the building's quality and permanent protection – all these factors guarantee the best advantages for the investor and the building contractor.

## How does an inverted roof function?

**1. In conventional flat roof system the waterproofing membrane is laid over the thermal insulation layer.** While the waterproofing membrane provides thermal insulation against atmospheric condensation, it is at the same time exposed to wide temperature fluctuations and the effects of UV radiation.

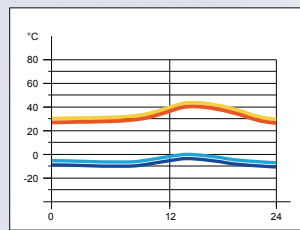
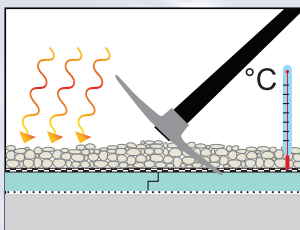
Due to the cooling/overheating cycles the material contracts/expands, which gradually leads to its failure. Consequently the nonelastic waterproofing layers suffer damage which can increase in case of mechanical loading. The membrane's durability depends on the material used.



The summer/winter temperature chart for conventional flat roofs with unprotected waterproofing membrane.

- - waterproofing membrane temperatures measured in summer
- - waterproofing membrane temperatures measured in winter
- - thermal insulation surface temperatures measured in summer
- - thermal insulation surface temperatures measured in winter

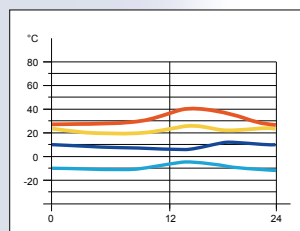
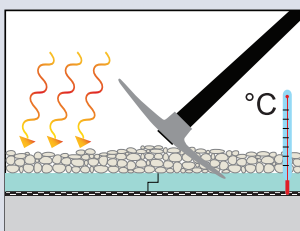
**2. Ballasting the roof surface diminishes the undesired temperature variations at the waterproofing layer level, while the protection against UV radiation increases the duration of the membrane's elasticity.**



The summer/winter temperature chart for conventional flat roofs shaded with gravel.

- - waterproofing membrane temperatures measured in summer
- - waterproofing membrane temperatures measured in winter
- - thermal insulation surface temperatures measured in summer
- - thermal insulation surface temperatures measured in winter

**3. The inverted warm flat roof has only one waterproofing membrane (compared to the non-protected warm flat roof),** fitted directly on the load-bearing construction or sloping platform. The roof is thermally and mechanically protected with thermal insulation made of extruded polystyrene (XPS). The temperature at the waterproofing layer level does not differ significantly from the temperature of the area below, both during summer and winter.



The summer/winter waterproofing membrane surface temperature chart for inverted flat roofs loaded with gravel.

- - waterproofing membrane temperatures measured in summer
- - waterproofing membrane temperatures measured in winter
- - thermal insulation surface temperatures measured in summer
- - thermal insulation surface temperatures measured in winter

# THERMAL INSULATION MADE OF EXTRUDED POLYSTYRENE FIBRANxps FOR FLAT INVERTED ROOFS

Thermal insulation boards, suitable for inverted roofs, have the required technical characteristics which satisfy the specific conditions of the application. The most important characteristics are minimum water absorption and sufficient compressive strength. Only certain thermal insulation products made of extruded foamed polystyrene (XPS) meet these requirements.

Minimum moisture absorption in FIBRANxps is achieved by a closed cell structure of material. The walls of the material's cells are also thin enough, so that the material's proper water vapour permeability is achieved. Long-term diffusion water absorption WD(V) as well as long-term submersion water absorption WL(T) must be – regarding thermal insulation used for inverted roofs – in the lowest possible range according to the SIST EN 13164 standard.

Thermal insulation type that is most suitable for inverted roofs has a declared compressive strength at 10% deformation CS(10Y) of **at least 300 kPa**. Considering the conditions of roof loading, products of various compressive strengths are chosen (Chart 1).

Thermal insulation products from groups with extremely low moisture absorption in long-term diffusion moisturizing, are suitable for this purpose, such as group **WD(V)5** or even lower, **WD(V)3**. According to EN 13164, WD(V) means a declared level of long-term water absorption by diffusion.

Due to the reduced efficiency of thermal bridges at joints of FIBRANxps boards, insulation boards with graded (L) edge (rebated join) must be installed.

**The required characteristics guarantee adequate thermal insulation characteristics throughout the roof's lifespan.**

Chart 1: FIBRANxps products in compliance with inverted roof requirements

|                          | Shape of profile | Surface | Declared level of compressive strength at 10% deformation CS(10Y) [kPa] | Declared level of long-term water absorption by diffusion WD(V) [vol. %] | Declared level of long-term water absorption by immersion WL(T) [vol. %] |
|--------------------------|------------------|---------|---|--|--|
| FIBRANxps <b>300 - L</b> | L                | smooth  | 300   | 3  | 0,7  |
| FIBRANxps <b>400 - L</b> | L                | smooth  | 400   | 3  | 0,7  |
| FIBRANxps <b>500 - L</b> | L                | smooth  | 500   | 3  | 0,7  |
| FIBRANxps <b>700 - L</b> | L                | smooth  | 700   | 3  | 0,7  |

For detailed technical specifications, please see the product catalog FIBRANxps

Final choice of FIBRANxps-type product in compliance with the requirements of specific building depends on statics expert's requirements.

**The thickness of thermal insulation** is specified individually for each building in the study of building physics. During the planning process extra attention is paid to the **insulation** thickness especially regarding the construction elements of the building exposed to wide temperature fluctuations (such as the roof). In the case of the inverted flat roof, which has a significantly longer lifespan, one must consider the insulation thickness in

the long term. Due to energy crisis and changed climatic conditions (especially hotter summers) **the present requirements regarding thermal insulation thickness are not sufficient**. These are set – depending on the size of the building, type of construction, shape, building orientation, location, intended use and several other conditions – by Regulations for efficient use of energy and calculated using the **ARCHI MaiD** programme.

# How to construct an inverted roof and why?

## 1. WATERPROOFING LAYER

The waterproofing membrane is fitted directly on the load-bearing horizontal construction or sloping platform with secured drainage at its lowest point. Minimum inclination depends on the type of the waterproofing layer and thickness of its joints that represent a water barrier. The inclination of flat smooth surfaces that guarantees efficient water drainage is app. 1,5%, but due to anomalies shown in practice, the inclination of minimum 2% is recommended. Waterproofing membranes must be fitted on the surface according to the professional rules. The drainage system has to be calculated

and executed according to professionally determined climatic characteristics of the building's location. To avoid unnecessary roof sanitation, extra attention needs to be paid to the angles, edges, penetrations, outflows and other critical details of waterproofing membrane installation. Angles that could damage the membrane are turned into blunt angles (and thus mitigated) prior to its installation. Blunt angles under the waterproofing membrane are executed with FIBRANxps triangular batten (XPS cornice).



## 2. FIBRANxps THERMAL INSULATION

The waterproofing membrane is protected against wide temperature fluctuations, UV radiation and mechanical damage with rigid FIBRANxps thermal insulation boards. The inverted roof is »turned upside-down« as FIBRANxps is placed above the waterproofing layer and is not protected from rainfall. Thermal insulation must be laid on the waterproofing membrane in a single layer to prevent water vapour from appearing between two boards. Such vapour acts as a steam barrier, thus weakening the lower board's insulation effect. If placing the boards in multiple layers cannot be avoided, the

construction complex must be constructed so that vapour congestion is prevented. In this case, the DUO, or even better, the DUO OPTIMO inverted roof system is recommended (pages 14 and 15). DUO roofs are used in case of extreme thickness of planned thermal insulation in low-energy and passive buildings...

When the existing roof is upgraded or adapted, the PLUS roof system can be used (page 14). The structure and all related details of such a roof have to be checked by a construction physicist.



## 3. PROTECTIVE LAYERS

DRAINAGE, ROOT BARRIER COURSE, STEAM-LEVELLING LAYER, SEPARATING LAYER, TOP LAYER  
**Water is drained from the roof surface in two levels:** above and below the thermal insulation. Most rainwater flows off through the outflow at the surface of the top layer, whereas in case of gravel top layer it flows off the surface of the insulation. Water that disappears between the joints of thermal insulation boards, flows off the surface of the waterproofing membrane. Both the drainage system and the outflows need

to be dimensioned in accordance with the anticipated quantity of local rainfall. Should water drainage fail to be efficiently executed, this would cause more lifting power in case of downpours, therefore the drainage needs more attention.

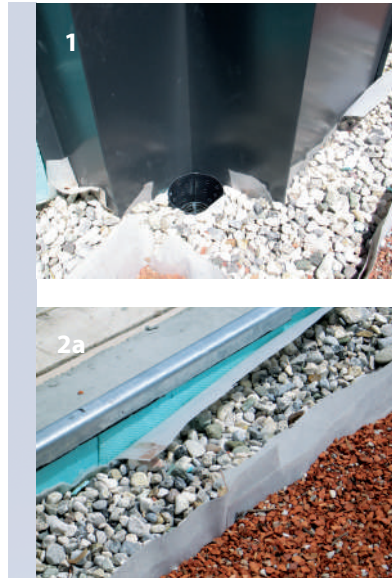
Water drainage regarding the tubes' diameter and roof surface is specified in Chart 2.

**Geotextile (filter layer)** is an indispensable layer of the inverted roof that can act as a steam-levelling or separation layer if necessary, thus preventing smaller parts from being washed under the thermal insulation boards, where they could damage the waterproofing layer. At the same time filter layer also prevents the formation of an impermeable layer of thin small parts on the surface of FIBRANxps boards, resulting in more lifting power.

**The water retention layer** is an element which can diminish humidity. It is placed directly on the thermal insulation and is covered with the filter layer which prevents alluvial silt and mud from penetrating into the drainage layer.

**The root barrier course** is used in intensely planted green roofs, where the waterproofing layer has to be protected against the invasion of aggressive roots. The root barrier course is placed directly on the waterproofing layer.

**A separating layer** above most waterproofing membranes is not needed, although it is needed between the PVC waterproofing membrane and the polystyrene thermal insulation, as the chlorides that are separated from the PVC foils cause the polystyrene foam to decay. The separating layer placed above the thermal insulation, e.g. in case of additional construction works with light concrete, has to be sufficiently vapour-permeable to prevent undesired condensation. Separating layer can be geotextile made from polyester fibres, which is normally used as a filter layer.



Picture 1: Floor outflows when the roof is penetrated during the installation phase

Pictures 1, 2a, 2b: The drainage and loading part at the rim of the wall and beside the roof transfixions

**Top layers – loading elements**

The FIBRANxps thermal insulation does not require a completely dry environment as it insulates in humid environments, though it has to be protected against UV radiation, wind uplift force and water’s lifting power. The thermal insulation of the inverted roof is protected by the upgrading, consisting of the drainage and the loading elements. The loading surface, which is needed



Chart 2: Outflow tubes’ diameter regarding the intended function and the roof’s surface

| Tube diameter | Drainage surface [m²] |        |            |
|---------------|-----------------------|--------|------------|
|               | Flat roof < 15°       | Gravel | Green roof |
| 70            | 70                    | 112    | 187        |
| 100           | 187                   | 300    | 499        |
| 125           | 337                   | 540    | 899        |

due to the wind action and the lifting power, represents (together with the load-bearing thermal insulation FIBRANxps) a possibility for utilizing the roof’s surface. The type of loading depends on the additional intended function (no traffic, foot traffic, vehicular traffic), and on the desired visual effect of the roof, terrace or balcony (gravel, wood, pavers, concrete slabs, asphalt, extensive or intensive vegetation...).

When the drainage **geotextile** is used, the loading which balances the lifting power can be independent from the insulation's thickness. During heavy downpours individual drainage elements (drainage geotextile, gravel wrapped with drainage geotextile, perforated warty foil or other water retention layer with drainage geotextile...) enable fast drainage of most rainwater, thus preventing the effect of increased lifting power. The drainage connects the insulation boards, thus significantly reducing the influence of wind uplift force on an individual plate in the central part of the roof's surface. By installation of drainage

the required loading is reduced to the equivalent of 5 or 6 centimetres thick layer of gravel. However one needs to calculate whether by doing so the wind uplift force at a certain location on the roof is properly addressed. The higher the building the stronger the effect of the wind, therefore in higher buildings the thermal insulation needs to be loaded at the rim of the building with larger loads in the width of at least one meter (see Chart 3). Peripheral gravel, concrete slabs and similar elements can be used at the rim of the roof which also act as an obstacle to fire spreading. Recommended gravel fraction is 16/32.

Chart 3: Guidelines for inverted roofs planning (ÖNORM B 6253)

| Height of the building [m] |                 | Meteorological measurements of wind speed [km/h]                                       |     |     |
|----------------------------|-----------------|--|-----|-----|
|                            |                 | 90   | 120 | 150 |
|                            |                 | Minimal <sup>(1)</sup> gravel thickness <sup>(2)</sup> for loading <sup>(3)</sup> [cm] |     |     |
| h ≤ 10 m                   | Central surface | 5  | 5   | 8   |
|                            | Rim zone        | 9  | 16  | 24  |
| 10 < h ≤ 25                | Central surface | 5  | 6   | 10  |
|                            | Rim zone        | 11   | 19  | 29  |
| 25 < h ≤ 199               | Central surface | 5  | 8   | 12  |
|                            | Rim zone        | 13   | 23  | 35  |

1 Intermediate values can be subjected to linear interpolation  
 2 Considering gravel layer density of 1900kg/m<sup>3</sup>  
 3 When other material is used the required thickness is calculated according to its density

In case of the inverted roof one needs to execute all details of the waterproofing protection carefully and professionally, whereas the upgrading superstructure with thermally insulated boards, drainage and the top layer is quite simple. The installation is simple, and so is the dismantling - in case the intended use of the roof is changed.

**The surface of the inverted roof offers mechanical resistance, therefore all maintenance works for equipment that is fitted on it can be executed with no risk regarding damaging of the waterproofing layer.**

Concerning the loading of the green inverted roof one needs to consider the specific weight of dry soil which must comply with the above mentioned requirements. The loading of the roof construction with wet soil needs to be considered regarding its dimensioning. The vegetation loading (according to Chart 4) has to be taken into consideration regarding the loading and the dimensioning of the construction.

Chart 4: Vegetation loading

| Type of vegetation         | Surface loading   |                   |
|----------------------------|-------------------|-------------------|
|                            | kg/m <sup>2</sup> | kN/m <sup>2</sup> |
| Turf, grass                | 5,0               | 0,05              |
| Small shrubs               | 10,0              | 0,10              |
| Shrubbery up to 1,5 m high | 20,0              | 0,20              |
| Shrubbery up to 3 m high   | 30,0              | 0,30              |
| Shrubbery up to 6 m high   | 40,0              | 0,40              |
| Trees up to 10 m high      | 60,0              | 0,60              |
| Trees up to 15 m high      | 150,0             | 1,50              |

Note:  
 German and Austrian guidelines for inverted roof production have been used



# MAKE GOOD USE OF FLAT ROOF SURFACE AND ENJOY SUSTAINABLE COMFORT

Due to the diversity of top layers flat inverted roofs offer countless possibilities for creative ideas to both planners and users. An otherwise unused roof can be arranged as a terrace where relaxing moments can be enjoyed, a handy garden can be arranged, while a flat surface can be turned into a parking deck.

The inverted roof construction type offers a whole spectrum of solutions for a lasting protection of the building against rainwater, thermal losses and summer overheating, while offering a possibility for making good use of the surface. Suitable for roofs, terraces, balconies or dug-in buildings. Several details are described in the following examples.

**Individual protection and loading layers in shown details, protection elements, dilatation elements and drainage elements can be optionally combined regarding the surface's intended use or regarding the requirements of individual top layers or the type of vegetation in case of green roofs.**



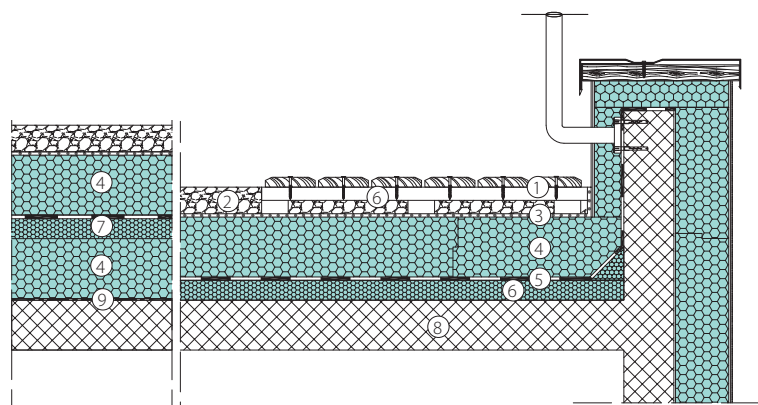
## A roof or an additional floor?

### When planning flat inverted roofs it is necessary to:

- calculate the load-bearing capacity of the construction / building due to additional loading,
- plan the inclination of the surface to drain water off the waterproofing membrane level,
- carefully design the drainage zones and outflows,
- carefully design details of the roof's edge, attica, various penetrations of the roof,
- plan walkways in case of larger or intensely used surfaces,
- adjust safety measures in the area with strong winds or taller buildings,
- take into account the regulations regarding safety fences in case of foot or vehicle trafficked surfaces.

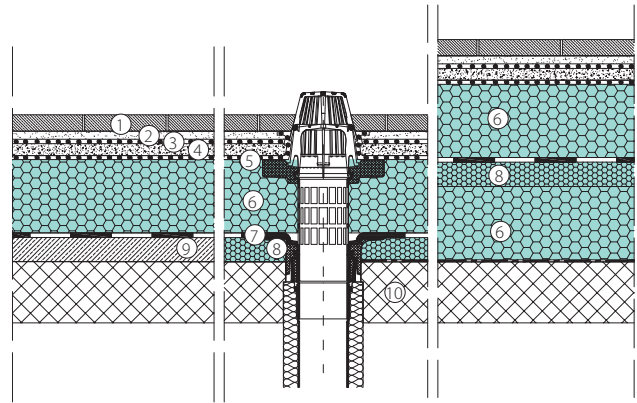
*Showing the final layer with gravel and wooden floor with fence detail*

- 1 wooden floor attached to batten
- 2 16/32 fraction gravel
- 3 filtering layer min. 140 g/m<sup>2</sup>
- 4 FIBRANxps **300-L**
- 5 waterproofing membrane
- 6 inclined breeze concrete or FIBRANxps **INCLINE**
- 7 FIBRANxps **INCLINE**
- 8 load-bearing construction
- 9 vapour barrier, if needed



*Floor outflow detail – paving stones placed in sand*

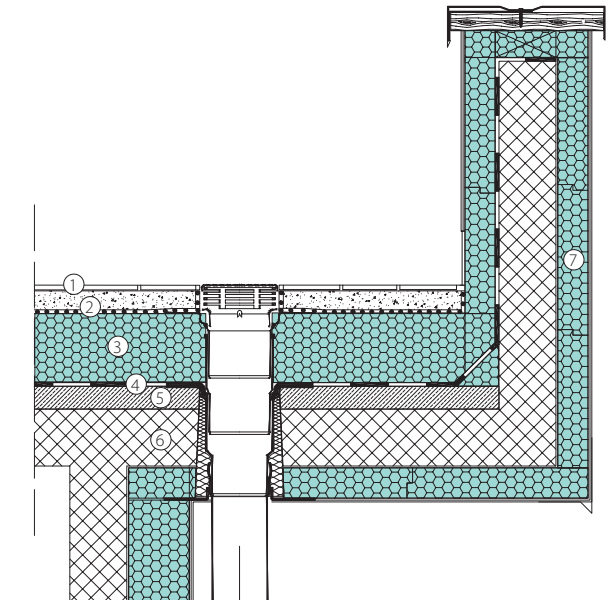
- 1 concrete pavers
- 2 sand
- 3 filtering layer min. 140 g/m<sup>2</sup>
- 4 gravel
- 5 filtering layer
- 6 FIBRANxps\*
- 7 waterproofing membrane
- 8 inclined breeze concrete or FIBRANxps **INCLINE**
- 9 inclined breeze concrete
- 10 load-bearing construction
- 11 vapour barrier, if needed



\* Type of FIBRANxps product is chosen according to the designed load

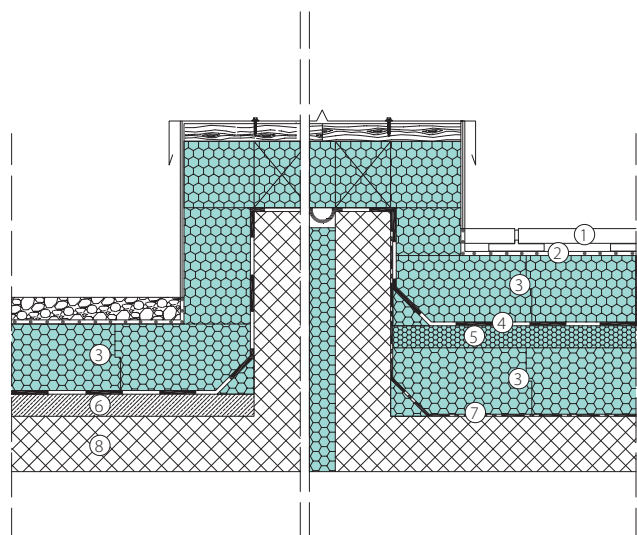
*Floor outflow on balconies and terraces*

- 1 ceramic tiles in cement screed
- 2 filtering layer min. 140 g/m<sup>2</sup>
- 3 FIBRANxps
- 4 waterproofing membrane
- 5 inclined breeze concrete or
- 6 FIBRANxps **INCLINE**
- load-bearing construction
- 7 **ETICS** facade system

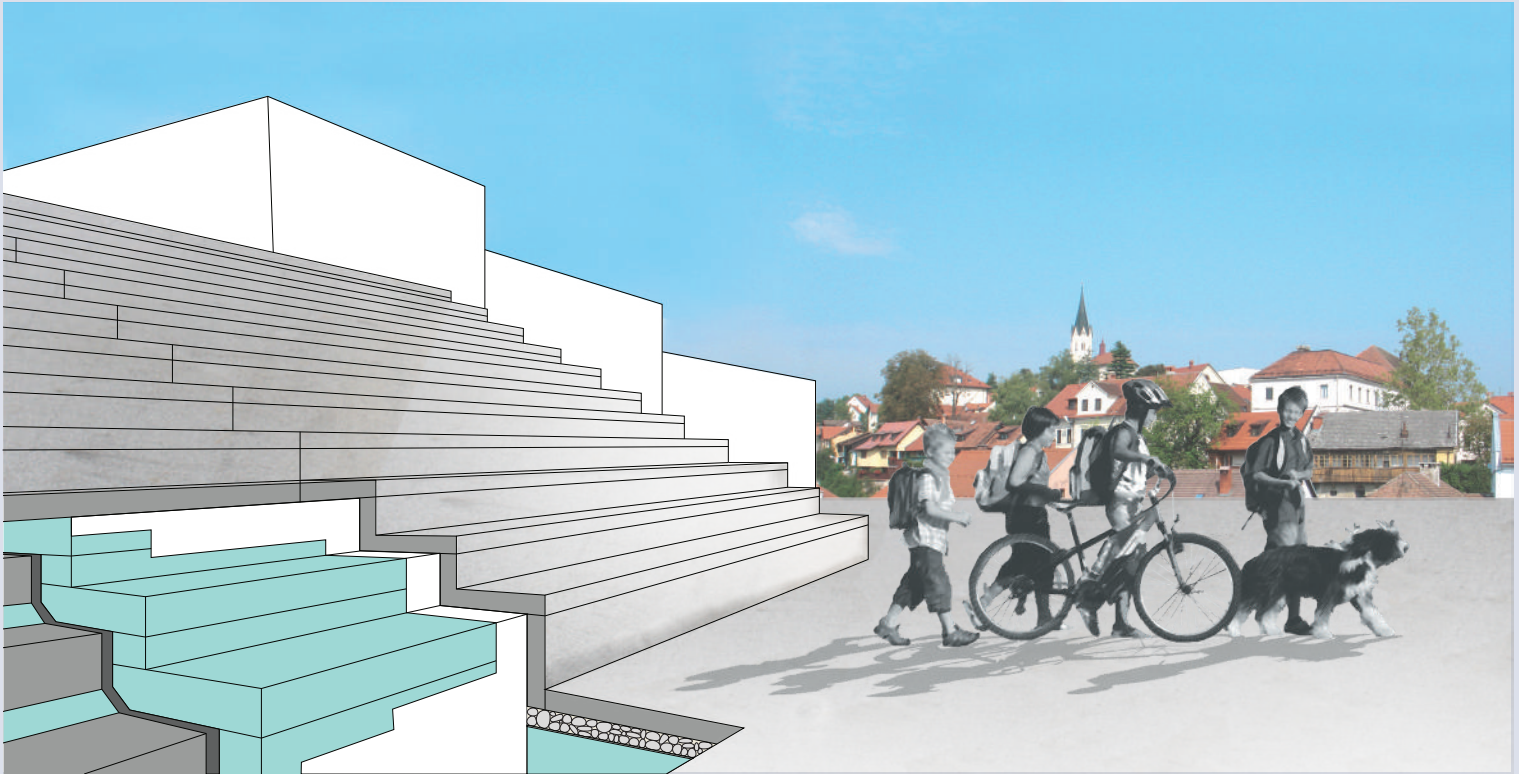


*Detail of the implementation of construction dilatation, an example of concrete plates placed on spacer elements and an example of gravel loading*

- 1 concrete slabs placed on spacer elements
- 2 filtering layer min. 140 g/m<sup>2</sup>
- 3 FIBRANxps
- 4 waterproofing membrane
- 5 FIBRANxps **INCLINE**
- 6 inclined breeze concrete or FIBRANxps **INCLINE**
- 7 vapour barrier, if needed
- 8 load-bearing construction

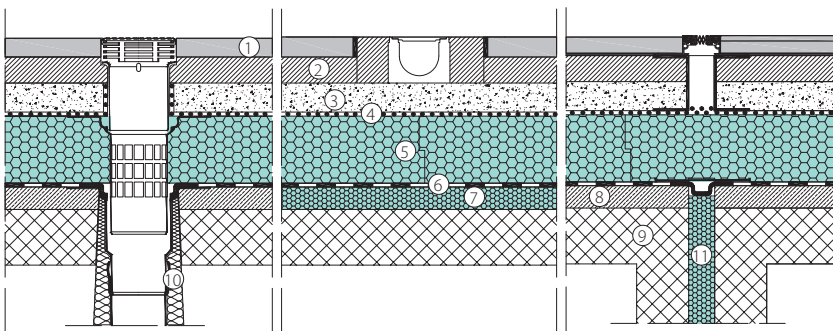
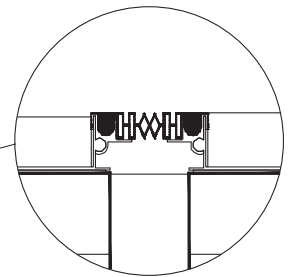


Sports fields, parking decks...



A spectators stand as a roof of the building; sports field on a roof

Water outflow, water drainage and construction dilatation of asphalt roof surfaces, sportfields, parking decks...



- 1 asphalt
- 2 concrete
- 3 gravel
- 4 filtering layer min. 140 g/m<sup>2</sup>
- 5 FIBRANxps (type depends on loadings)
- 6 waterproofing membrane
- 7 FIBRANxps **INCLINE**
- 8 inclined breeze concrete
- 9 load-bearing construction – concrete slab
- 10 mineral wool FIBRANgeo
- 11 FIBRANxps



## Roof garden

The flat inverted roof construction system is extremely suitable for constructing a planted roof.

Each flat roof or a roof with small inclination offers a surface on which one can recreate a piece of lost nature in our concrete desert. This is one of the reasons why green roofs are more and more often designed for new buildings. Extensive planting, suitable for industrial, office and residential buildings, can be achieved quite simply as many non-demanding plants grow even on a thin layer of substratum without special care. If the substratum is thicker, vegetables, shrubbery or even trees can grow.

←..... Intensively greened inverted roof of underground car park



Composites of extensively greened roof. Roof is made of 20 cm thick FIBRANxps thermal insulation boards

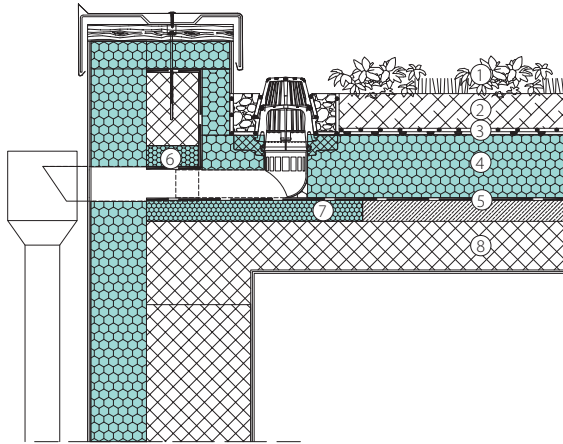
←..... Green roof on the top of a residential-business building contributes to the natural green appearance. Inverted green roof system was used also for the park area of the underground car park roof.

### **An inverted roof, upgraded with soil and vegetation, brings many additional advantages that enhance the living comfort:**

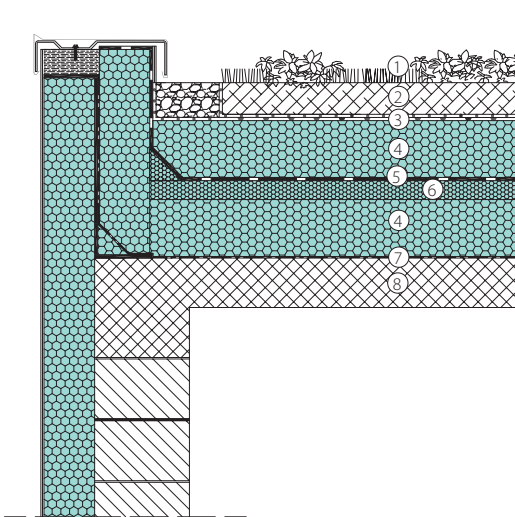
- enhanced thermal stability of the roof,
- better sound insulation of rooms,
- improved microclimate in the close vicinity of the building,
- pleasant dwelling in a green oasis,
- reduced quantity of rainwater in sewage.

### **When planning a green roof it is necessary to:**

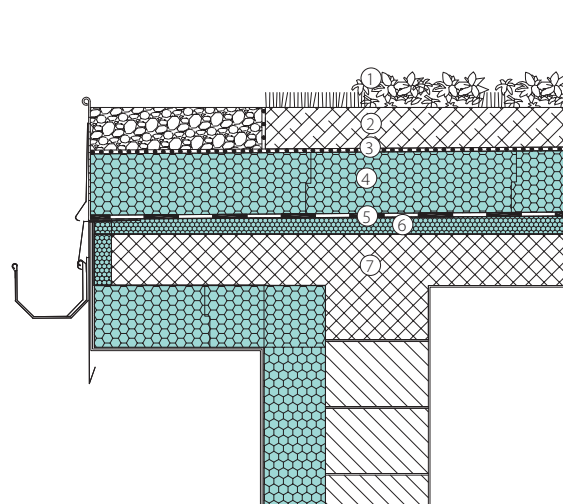
- calculate the load-bearing capacity of the construction / building,
- plan the inclination of the surface to drain water off the level of the waterproofing membrane,
- carefully design the drainage zones and outflows,
- in case of intensive green roof planting, plan manual or automatic irrigation,
- carefully design details of the roof's edge, fence, various penetrations of the green roof,
- place an anti-root barrier above the waterproofing membrane for plants with deeper or more aggressive roots,
- plan walkways in case of larger or intensely used surfaces,
- adjust safety measures in the area of strong winds or taller buildings,
- consider the regulations regarding safety fences in case of foot or vehicle trafficked surfaces.



The finishing of the green roof with parapet, flat roof outflow and side water outflow



The circumferential low walls base on metal subconstruction profiles



The edge of the green or gravel roof with the outflow gutter  
Note: If the console is shorter than 1m, the concrete slab must be thermally insulated

## Typical structure of a green roof:

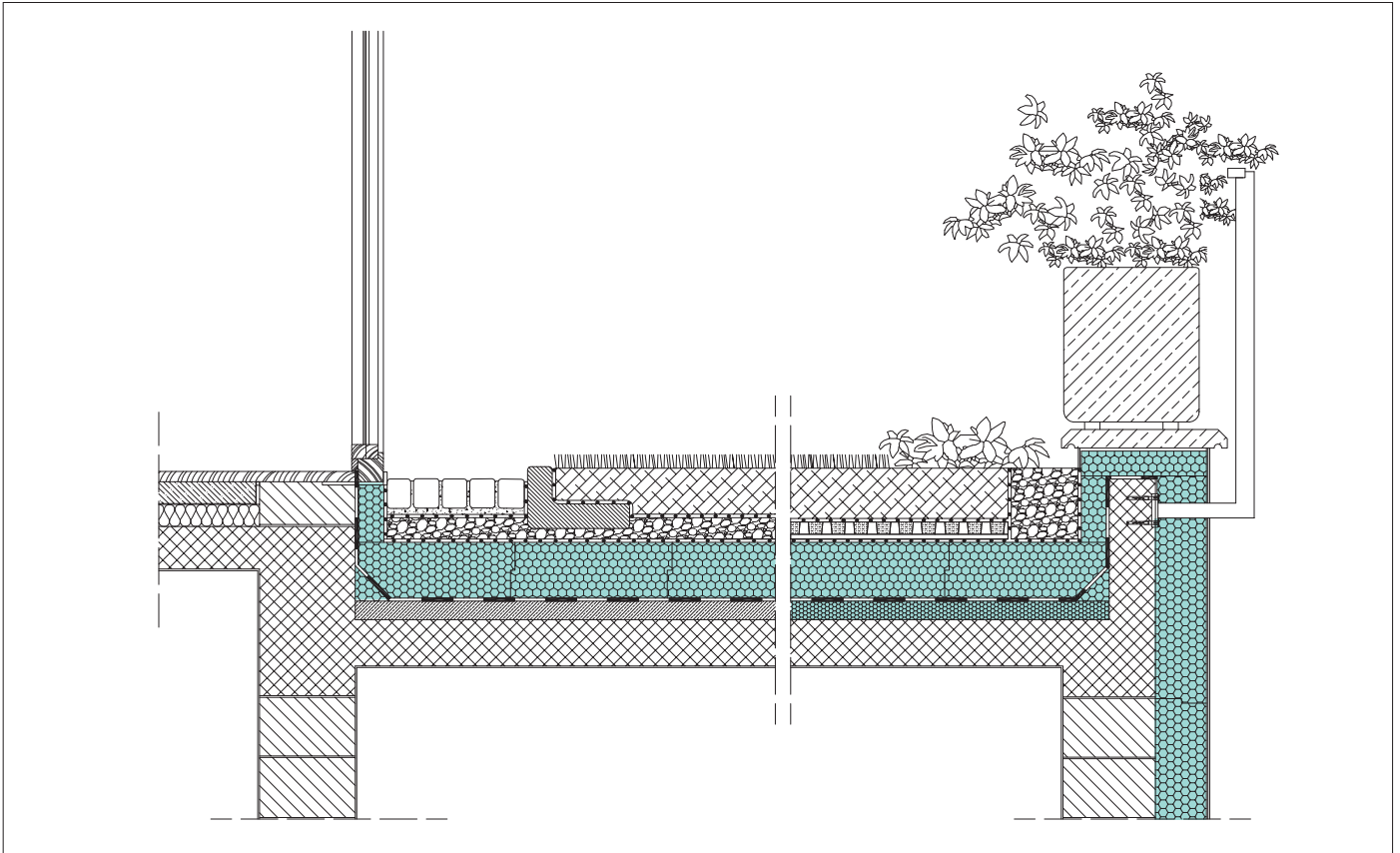
- 1 vegetation
- 2 multi-layered nutritional substratum
- 3 filtering layer
- 4 insulation made of extruded polystyrene **FIBRANxps 300 - L**
- 5 waterproofing and anti-root barrier
- 6 insulation of thermal bridge
- 7 roof construction with breeze concrete or **FIBRANxps INCLINE**
- 8 roof construction

### EXTENSIVE PLANTING

- 1 The extensive planting vegetation is a vegetation which is not demanding.
- 2 For this kind of vegetation a 10 cm layer of substratum is sufficient. After irrigation the roof is additionally loaded for approximately 1,5 KN/m<sup>2</sup> (150 kg/m<sup>2</sup>). The thickness of the required loading layer needs to be checked in accordance to the requirements in Chart 3 on page 6.
- 3 A water retention layer (perforated foil with small cups) with the filtering veil:
  - represents a layer for water filtering and retaining,
  - acts as the primary anti-root barrier,
  - acts as a steam-levelling layer in case of poor permeability of compact soil
- 4 **FIBRANxps 300 - L**
- 5 waterproofing and anti-root barrier,
- 6 roof construction with **FIBRANxps INCLINE**
- 7 vapour barrier, if needed
- 8 roof construction

### INTENSIVE PLANTING, A HANDY VEGETABLE GARDEN, A TERRACE GARDEN

- 1 The **simple intensive planting** vegetation is grass, perennials, vegetables.
- 2 Before the thickness and structure of the soil substratum are determined, a consultation with an expert is advisable regarding the plants chosen for planting the green roof. Usually a 20 cm multi-layer nutritional substratum is enough for this kind of vegetation. After irrigation the roof is additionally loaded for approximately 3 KN/m<sup>2</sup> (300 kg/m<sup>2</sup>).
- 3 A filtering veil placed on the water retention layer is used for the green roof with simple intensive planting.
  - 1 In case of **intensive planting** shrubbery and trees can be planted apart from the simple vegetation.
  - 2 For this kind of vegetation a minimum 50 cm of multi-layer nutritional substratum is required. After irrigation the roof is additionally loaded for approximately 7,5 KN/m<sup>2</sup> (750 kg/m<sup>2</sup>).
  - 3 In case of green roof with intensive planting we can use a filtering veil placed on a water retention layer or gravel wrapped in filtering veil.
  - 4 **FIBRANxps 300 - L** (type depends on loadings)
  - 5 An anti-root barrier needs to be placed above the waterproofing membrane (e.g. waterproofing membrane with the ALU foil) for plants with deeper or more aggressive roots.
  - 6 roof construction with breeze concrete or **FIBRANxps INCLINE**
  - 7 roof construction



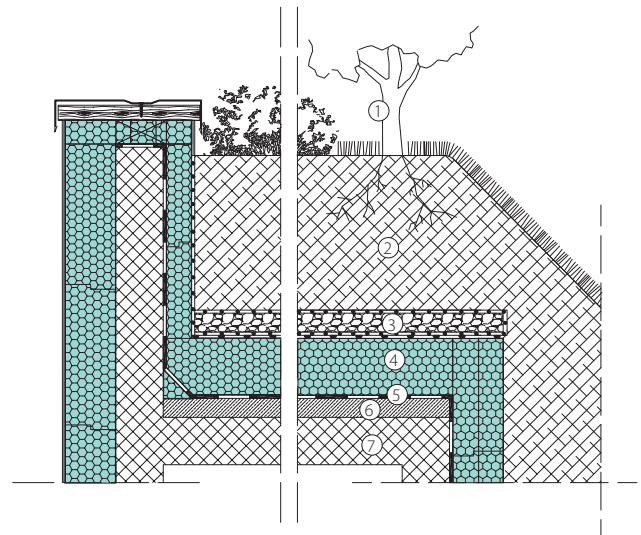
Terrace of a residential or office building

**PLANTING OF THE UNDERGROUND BUILDINGS**



- 1 In case of planting of the underground buildings shrubbery and trees can be planted apart from the simple vegetation.
- 2 Water reservoirs, for example, require as constant a temperature as possible, during winter and summer, therefore it is advisable to augment the soil's thickness to 80 cm. After irrigation the roof is additionally loaded for approximately 12 KN/m<sup>2</sup> (1200 kg/m<sup>2</sup>).
- 3 For planting of the underground buildings a filtering veil is placed onto the water retention layer. In case of larger soil thickness gravel could be wrapped in the filtering veil.
- 4 **FIBRANxps 300-L**

- 5 An anti-root barrier needs to be placed above the waterproofing membrane for plants with deeper or more aggressive roots.
- 6 roof construction with breeze concrete or **FIBRANxps INCLINE**
- 7 roof construction



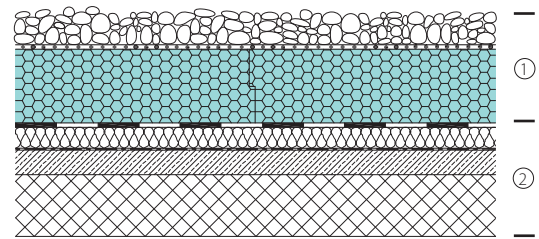
Maintaining a stable temperature and preventing waterproofing membrane damage in a water reservoir

## PLUS ROOF – Upgrading and renovation of an existing roof

When upgrading the thermal insulation of the existing classic flat roof or in case of its sanitation, additional insulation can be installed without any special construction interventions.

First the quality of the existing waterproofing membrane and water drainage is checked and, if necessary, sanitation is executed. Then FIBRANxps boards and the drainage element are placed, continued with the upgrading according to the requirements of a specific finishing layer. When calculating the construction physics the thickness of the existing thermal insulation can be taken into consideration, as it was installed, though with reservation. It is useful to check the existing condition of the thermal insulation and the quantity of humidity underneath the existing waterproofing membrane, and to reduce the calculated thickness of the existing thermal insulation if necessary. The roof upgraded in such a manner is called a PLUS roof.

PLUS roof



- 1 inverted roof system
- 2 existing



Classic flat roof...

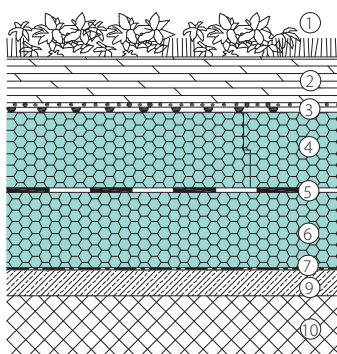


...after renovation

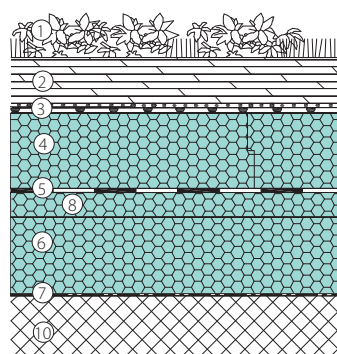
## DUO ROOF – Flat roof of low-energy buildings

The DUO roof is a combination of classic and inverted roof and is used for new buildings when the requirements regarding the U-value (thermal transmittance of the structure) of the inverted roof are larger than those achieved with one layer of FIBRANxps thermal insulation. In case of low-energy buildings (with very thick thermal insulation) the vapour barrier is mostly not necessary, but this needs to be checked by calculation of physical properties according to the principles of building physics.

DUO roof



DUO OPTIMO roof



- 1 vegetation
- 2 substratum
- 3 filtering layer with water-retention layer
- 4 FIBRANxps **300-L**
- 5 waterproofing membrane
- 6 FIBRANxps **300-L**
- 7 vapour barrier, if needed
- 8 FIBRANxps **INCLINE**
- 9 inclined breeze concrete
- 10 load-bearing roof construction

In case of DUO OPTIMO roofs the sloping insulation boards FIBRANxps **INCLINE** can be placed above the first layer of thermal insulation boards FIBRANxps **300-L**.



The following obstacles can arise when designing, but mostly when renovating flat roofs and terraces:

- When repairing or renovating flat roofs with the inverted roof system, the **increased load** is not recommended.
- When repairing the existing foot trafficked terraces, it is difficult to provide sufficient thickness of thermal insulation, due to **height restrictions**.
- Roofs on low-energy and passive buildings, especially green roofs, which are part of sustainable building, **increase the thickness and weight** of the entire roof construction.

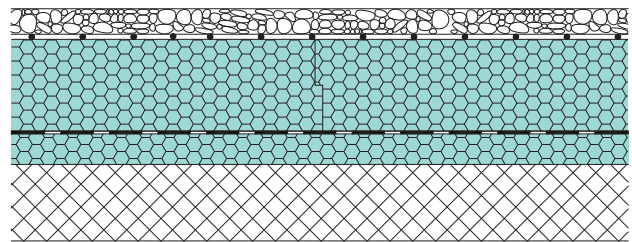
The answer to these three different problems lies in a single solution:

## OPTIMO ROOF – The optimum construction of flat roofs

**OPTIMO roof is one of the improvements of flat roofs: instead of sloping concrete, a special element is built into the roof – a light-weight thermal insulation FIBRANxps INCLINE.**

Advantages of using sloping insulation boards FIBRANxps **INCLINE**:

- **Load on the roof is reduced for the total weight of the sloping concrete**, which roughly equals the load of the top layers on the non-trafficked or foot trafficked and extensive green inverted roofs.
- **Thermal insulation capacity is increased or overall thickness of thermal insulation is reduced.** Sloping insulation FIBRANxps **INCLINE** adds to thermal resistance of the roof, which can be taken into consideration when designing the thickness of thermal insulation.
- **Decreased thickness of the sloped layer.**



Note:

*If bituminous membrane is used as a waterproofing layer, then the first layer is fitted on FIBRANxps INCLINE with self-adhesive membrane, as using open fire in the vicinity of polystyrene boards is not permitted.*

By using thermal insulation FIBRANxps **INCLINE** in **OPTIMO** roof system, the load is reduced, the height is increased, and the thermal performance upgraded.

### Instructions regarding the use of FIBRANxps thermal insulation material for flat roofs:

FIBRANxps thermal insulation boards from extruded polystyrene can remain unprotected outside for several weeks and remain unaffected by rain, snow or frost, but this is not the case with sunlight. The foamed polystyrene boards, like other hard foam synthetic materials, are sensitive to long-term exposure to ultra-violet light. When installing FIBRANxps boards onto the roof surface these boards need to be simultaneously protected against the sun's radiation, therefore immediate installation of other layers is recommended. Boards that are not installed immediately at the construction site need to be placed into shade or protected with a cover made of bright-coloured synthetic material. Temperature rises significantly under transparent or dark covers and can deform the boards or cause damage to their surface. Maximum usage temperature is 75°C as the boards' surface starts to melt in case of higher temperatures.

The use of open fire near FIBRANxps, and any other polystyrene thermal insulation is not permitted.

Boards from extruded polystyrene FIBRANxps have to be placed on flat and clean surfaces.

FIBRANxps is affected by solutions based on petrol, tar, formic acid, gases such as methane, ethane, propane, butane, heptane... FIBRANxps can conditionally exist in contact with petroleum (oil), heating

oil, paraffin oil, vaseline, phenol, fat and oil. These substances can long-term-wise affect the surface. Totally neutral regarding FIBRANxps are bitumen, lime, cement, plaster, as well as saltwater, lyes, acids including sulphuric and phosphoric acid, anorganic gases, alcohol, silicon...

Because of chlorides which are present when using a PVC waterproofing membrane, a separating layer (e.g. Geotextile) should be placed between the membrane and the polystyrene boards.

**All information given in this brochure are mere recommendations for planners of inverted roofs. The data has been obtained on the basis of standards of several European countries with long tradition and organized legislation regarding this subject.**

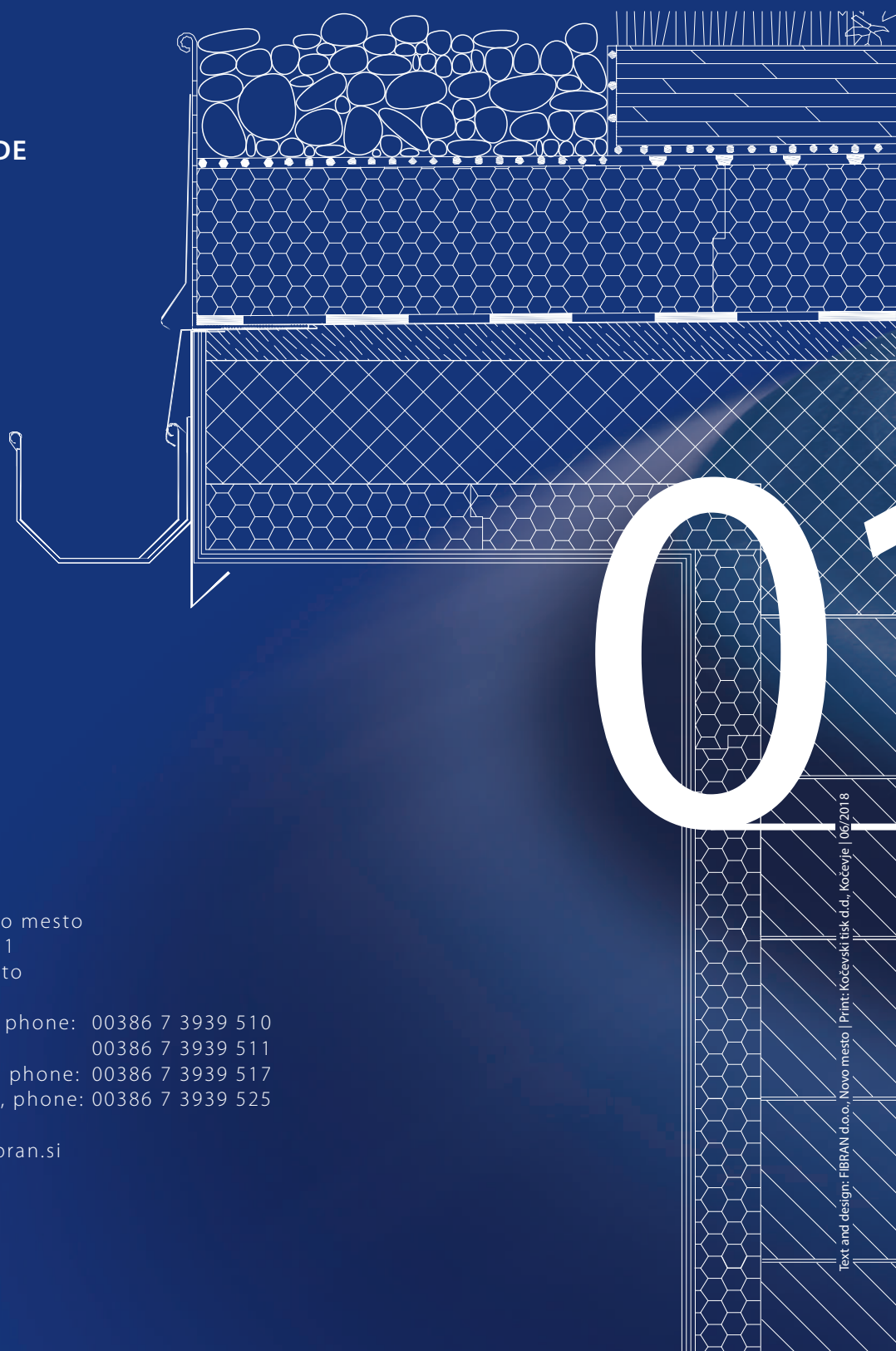
**Technical support division of FIBRAN d.o.o. is always available for architects and building contractors to help them clarify questions regarding characteristics and applications of FIBRANxps products. [www.fibran.com](http://www.fibran.com)**

0100 PRODUCT CATALOGUE

0111 INVERTED FLAT ROOFS

0130 FAÇADE

0150 BELOW GRADE



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