

Technical Guide

DELTA[®] protection and drainage system for horizontal application

Dörken – leading through competence. For more than 100 years.

Developed from innovative ideas and made in modern production facilities: The top-quality products offered by Dörken GmbH & Co. KG for foundation protection, drainage, and waterproofing set standards for reliability, durability, and energy conservation. Located in the Westphalian town of Herdecke, the company traditionally offers its clients high-quality products and customised solutions. Having lived up to this standard for more than 100 years, Dörken is and will always be a powerful partner for planners, dealers, and tradesmen.



All our drainage products, DELTA[®]-NP DRAIN, DELTA[®]-DRAIN, DELTA[®]-TERRAXX, DELTA[®]-GEO-DRAIN Quattro, DELTA[®]-GEO-DRAIN 800 TP conform to the requirements of the CE sign and those of the EN 13252 standard (Certificate No. 0799-CPD-13).



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Stringent Requirements in Horizontal Applications

Large flat roofs and ceilings covering underground parking lots and buildings need not remain unused. They are ideal for performing more useful functions as traffic routes, playgrounds, or leisure areas as well as for creating extra parking space. When partially or entirely planted with a herbageous covering, such areas may improve the microclimate in residential areas to a marked extent. In such cases, any water delivered by precipitation or possibly building run-off must be conducted away safely both at the surface and in the waterproof-

ing layer below, and a high-performance drainage system is needed even within these structures. Otherwise, stagnant water might destabilise the subgrade of traffic areas, plants might be damaged when their soil becomes waterlogged, and the whole might constitute an additional burden on the waterproofing system itself. Commercial mineral drainage systems consisting of gravel or chippings will meet these requirements only at great expense. Not only is there a danger of such structures becoming clogged up by sludge and

gradually losing their drainage capability, in consequence, the requisite minimum thickness of such a layer constitutes a handicap for planners and a static cost factor that must be taken into account.

DELTA[®] branded drainage sheets offer an economical alternative in these applications. The material combines low thickness with a high protective effect, a large drainage capacity, permanently stable filtration, high compression resistance, and outstanding durability.



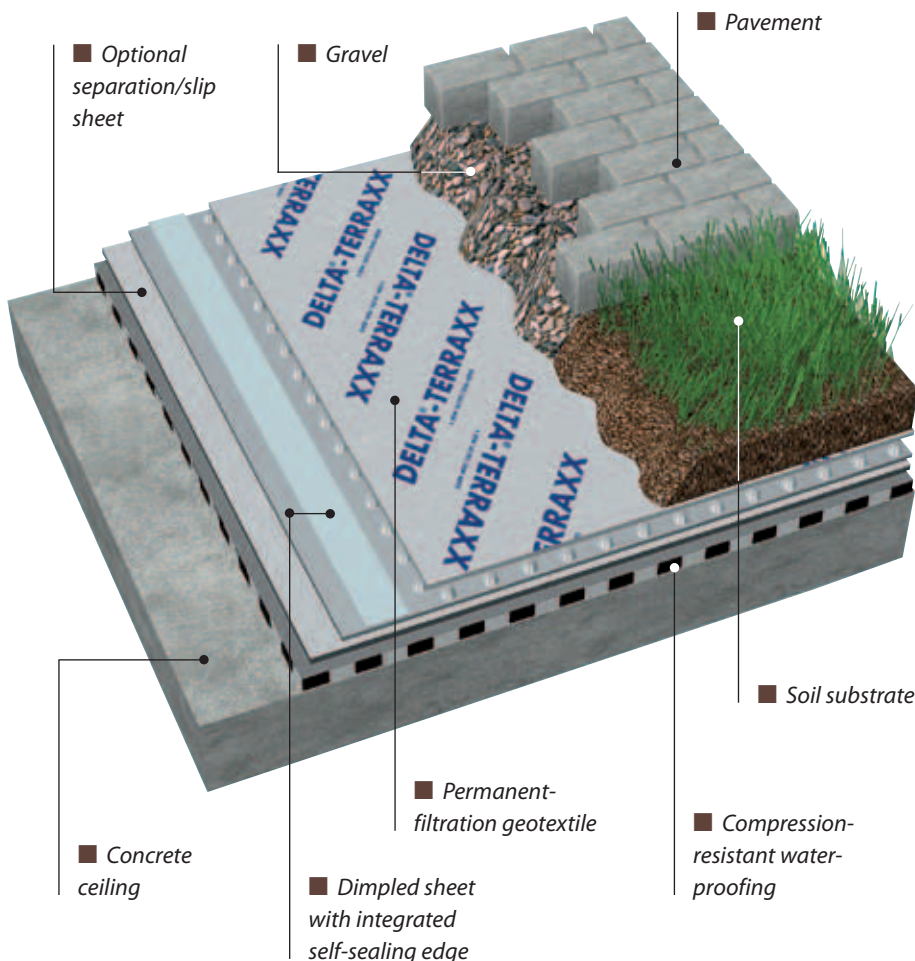
PREMIUM QUALITY

DELTA®-TERRAXX – the All-round Solution for Outstanding Protection

DELTA®-TERRAXX an extremely robust protection and drainage system, has been optimised for different applications in horizontal drainage. Consisting of a dimpled sheet with a fused-on geotextile, the composite material forms a highly effective drainage layer: Facing up, the geo-textile acts as a filter protecting the air gap created by the dimpled sheet underneath.

Under a covering of gravel, chippings, or soil, the heat-bonded permanent-filtration geotextile keeps the dimple structure from being clogged up by sludge, thus ensuring that any excess water is drained away completely and freely. Its integrated self-sealing edge makes the dimpled sheet easy to lay out and helps to prevent root penetration. The smooth backing of the

material ensures that any impinging loads are distributed evenly across the waterproofing surface. Thus, DELTA®-TERRAXX makes it safe for workers to walk on any compression-resistant waterproofing layers during the construction phase, at the same time protecting the waterproofing from mechanical damage and harmful exposure to heat.



DELTA®-TERRAXX is a powerful foundation for safe surface drainage.

The advantages of DELTA®-TERRAXX at a glance:

- Reliably protects and insulates waterproofing layers against mechanical damage.
- Withstands extreme compression loads of 400 kN/m² (up to type-60 heavy trucks, depending on the covering).
- High drainage capacity prevents frost damage and encrustations.
- Water-vapour pressure is drained away through the structure.
- Water drainage capacity exceeds that of gravel or chipping layers.
- No obstruction by sludge underneath the covering layer.
- Good load distribution prevents point loads on the waterproofing layer.
- Resultant static building loads lower than those of gravel layers.
- Easy and cost-efficient installation.

Horizontal Drainage Layers

Parking decks

Before a waterproofed parking deck can be paved with concrete, a drainage layer must be installed. This is done by laying out DELTA[®]-TERRAXX drainage sheeting on the separation/slip sheet covering the waterproof surface of the parking deck and applying the steel reinforcements on top, held in place by spacers. Once this is done, the concrete paving may be poured on directly. When installed, DELTA[®]-TERRAXX forms a drainage layer which keeps frost from damaging both the waterproofing and the pavement by preventing accumulations of water that might cause harm to these layers.

Walkways and flagstones

Under superstructures covered with paving stones or slabs, a drainage layer covering the entire surface will carry away safely and without delay any rainwater that may seep into the structure. In a layer of gravel or chippings, whose drainage capacity is limited, water may accumulate, expand as it freezes, and push the pavement upward. Even the waterproofing layer may be damaged by frost in these cases. Only a surface gradient of 4 to 5 % (cf. WTA instruction sheet E 5-21-07/D) ensures that water will drain away quickly enough. DELTA[®]-TERRAXX permits water to flow freely even under surfaces with a normal inclination,

thus helping to avoid the kind of damage described above. Similarly, the regulations for the roofing trade (Sect. 4.7.2.2, walkable roof decks) demand that roof terraces, for example, should be equipped with drainage layers to ensure that any water that reaches the waterproofing is drained away efficiently.

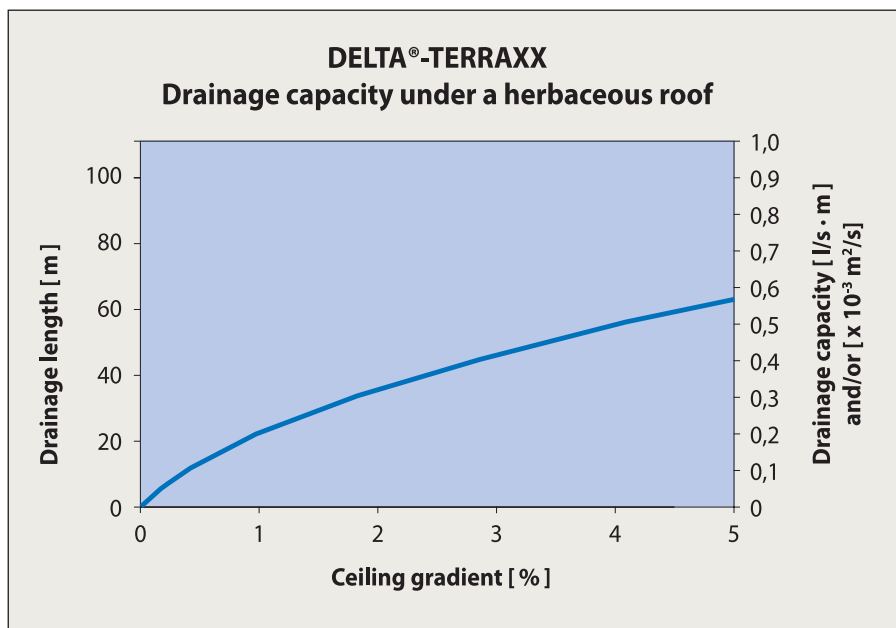
After the drainage layer has been laid out on the waterproofing it can be covered with sand, gravel, or chippings to which a covering of paving stones or slabs may be applied.



Soil-covered ceilings

DELTA®-TERRAXX also prevents water accumulations on soil-covered waterproofed ceilings. Any excess rainwater that cannot be stored in the vegetation layer is absorbed and carried off by the drainage layer across the entire surface, with the geotextile reliably preventing minuscule particles from penetrating into the drainage level.

When covered with soil, DELTA®-TERRAXX will support wheeled loaders during the construction phase, and the completed surface will even bear the weight of heavy fire engines, given a thick enough soil covering (see table on page 13).



The diagram shows the drainage capacity of DELTA®-TERRAXX under a common load of 20 kN/m² in relation to the ceiling gradient. Thus, for example, the drainage capacity is 0.32 l/s · m at a gradient of 2 % (maximum length: 35 m), soaring to 0.42 l/s · m at a gradient of 3 % (maximum length: ca. 45 m). The resultant drainage lengths are based on the specifications of DIN 1986-100, Sect. 9.3.2.: To arrive at the drainage length, the rainfall yield (commonly 0.03 l/s · m) is multiplied by a reduction factor (0.3 in the case of soil substrates).



Horizontal Drainage Layers



Protection and drainage of gravel-covered flat roofs

In conventional flat roofs, where the top protective covering consists of a layer of gravel, the top layer of waterproof sheeting is generally sheeted with PE material. However, these thin sheets afford no protection whatever from mechanical damage that might be inflicted on the waterproofing layer by gravel splinters, maintenance activities, or other external influences. Especially gravel that has been extracted 'pneumatically' is very likely to contain a higher proportion of fragments due to relatively high impact speeds during extraction, so that a robust protective layer

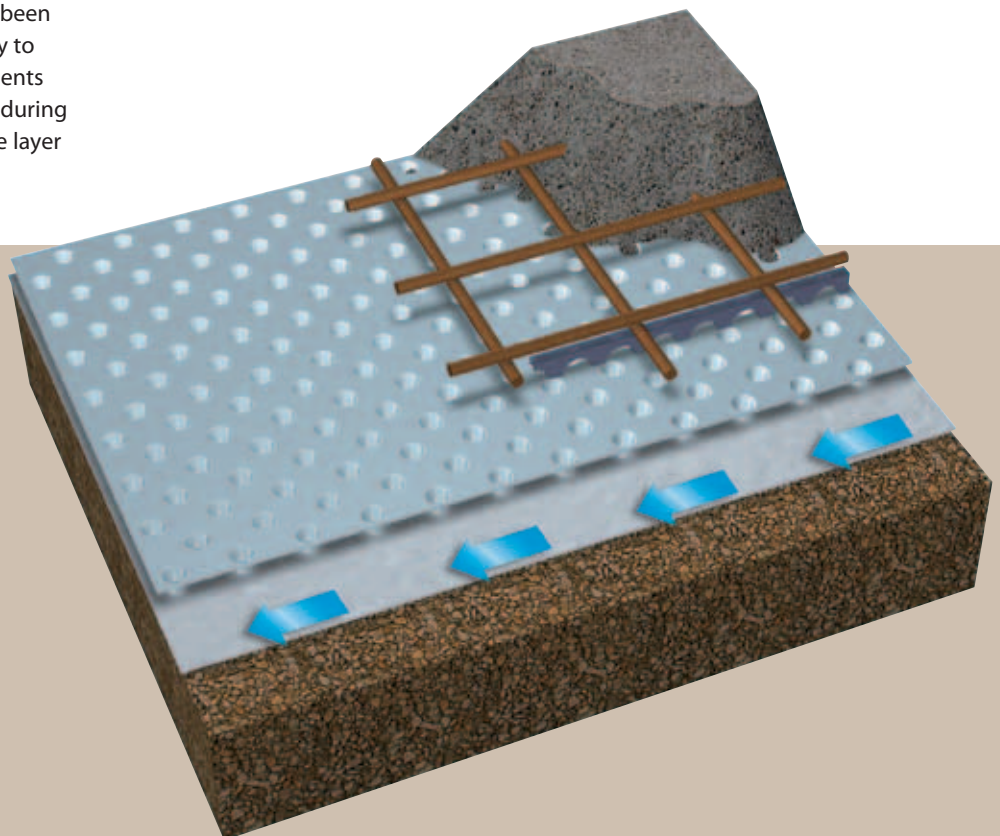
becomes indispensable. This is another problem which DELTA[®]-TERRAXX may help to solve. Laid out under gravel, the material forms a highly effective and cost-efficient protective layer. In addition to offering optimum protection to the skin of the roof, the sheets form an extremely efficient surface-drainage layer: Even after a gravel layer has become clogged up by sludge over the years, DELTA[®]-TERRAXX will reliably carry away any water above the waterproofing, thus permanently preventing the formation of water accumulations.

Horizontal drainage below foundation slabs

When a building is erected on a slope, the excavation often cuts into the aquifer. If the water emerges below the foundation slab, it must be drained off, not only to keep hydrostatic pressure from building up but also to avoid a negative impact on the water regime. To keep the impact on the natural behaviour of aquifer water to a

minimum, an efficient drainage system below the foundation slab is indispensable. In this instance, DELTA[®]-TERRAXX may constitute an alternative with a markedly better performance than a conventional horizontal drainage system consisting of a 30-cm mineral layer.

DELTA[®]-TERRAXX acts as a sub-base course, at the same time separating the foundation slab from the moist subsoil. Once the drainage sheets have been laid out with the cloth side facing downward, concrete may be poured on. The drainage capacity of the sheet will not change because the dimples are filled with concrete. Cement paste cannot seep into the ground when the concrete is poured. Drain pipes must be integrated in the continuous footing to catch and carry the aquifer water.



Application in building protection

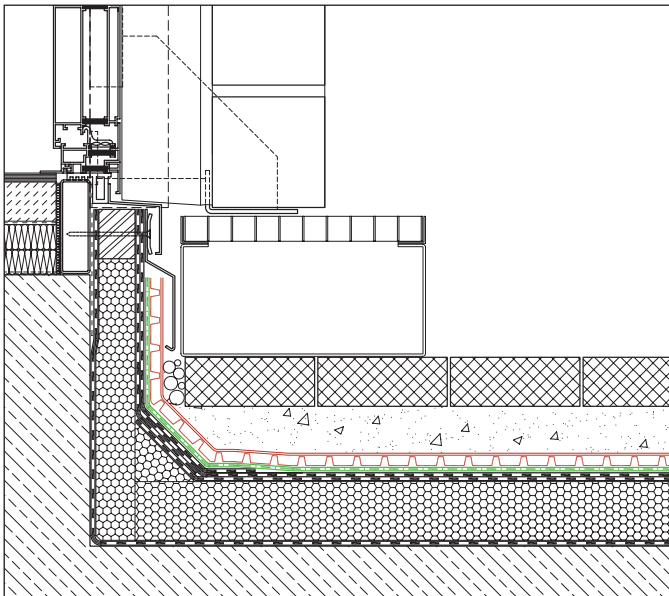
Building protection mats are subject to special requirements which granulated-rubber mats often fail to fulfil satisfactorily: While conventional sheets offer nothing more than protection, DELTA®-TERRAXX combines efficient protection with effective long-term drainage to avoid frost damage. At the same time, this keeps silt from accumulating under the surface layer.

When applied under concrete, asphalt, gravel, herbaceous coverings, paving stones, and slabs or on top of waterproofing layers, DELTA®-TERRAXX proves superior to granulated-rubber mats not only in terms of performance but also in terms of price and ease of laying: Its ideal width of 2.40 m (30 m² per roll) permits cost-efficient installation while its integrated self-sealing edge keeps the sheets from

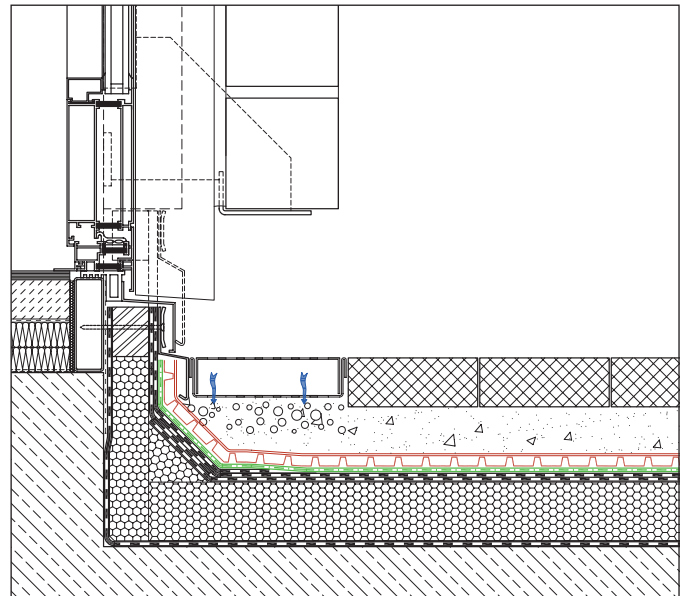
shifting. Lying flat like a board, sheets will retain their original shape even at high temperatures: They may be freely exposed to the weather for up to two weeks without any additional surface protection. Weighing no more than 0.7 kg/m², DELTA®-TERRAXX is ten times lighter than a granulated-rubber mat. Yet another crucial advantage comes to the fore on hot summer days, when granulated-rubber mats tend to emit a highly disagreeable odour while DELTA®-TERRAXX remains absolutely odourless.



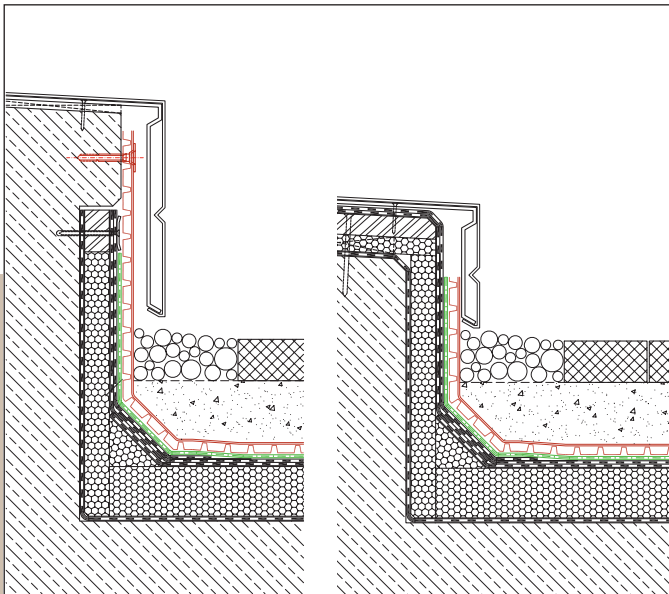
Overview of Technical Detail Solutions



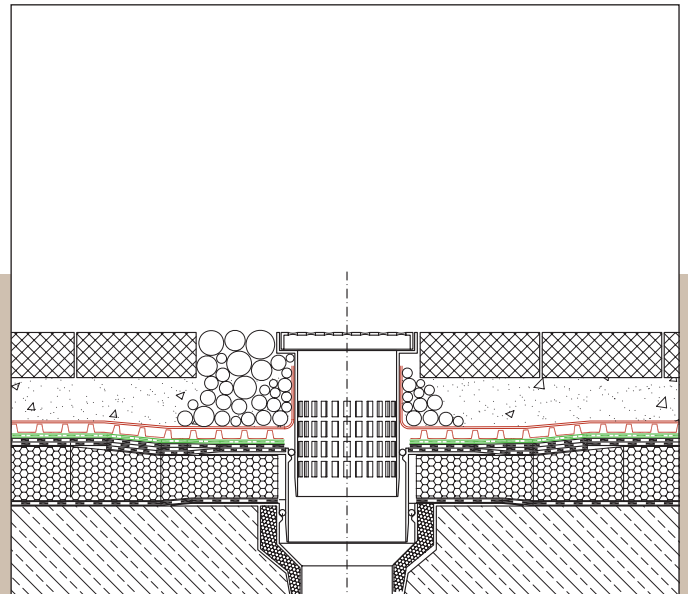
Accessible roof covered with paving stones or slabs. Connected to a door with an outside step. Splash guard height: 15 cm.



Accessible roof covered with paving stones or slabs. Connected to a barrier-less door with an outside box gutter.

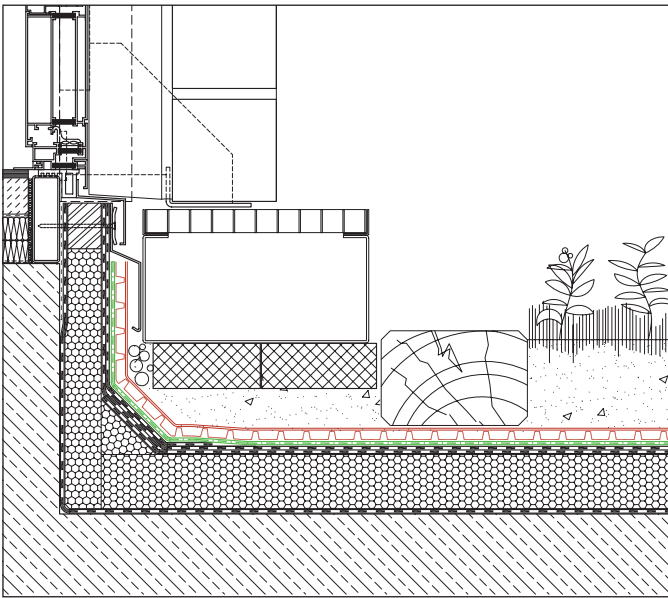


Accessible roof covered with paving stones or slabs. Roof edge/fascia.

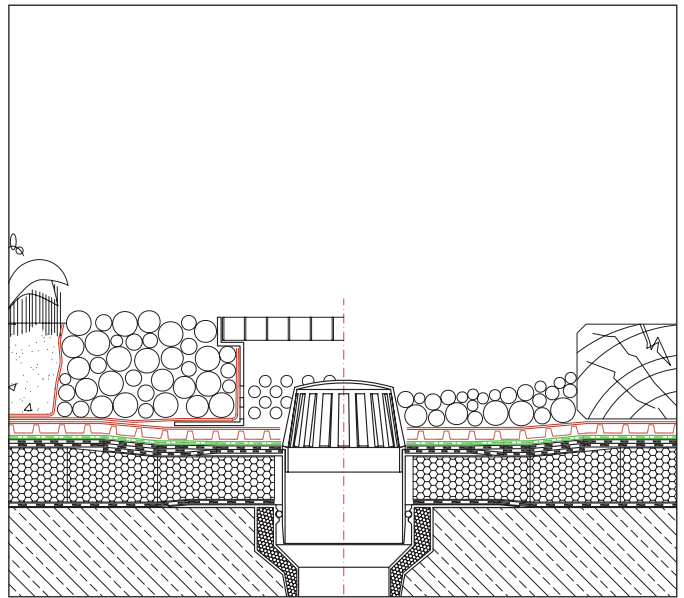


Accessible roof covered with paving stones or slabs. Roof drain connection.

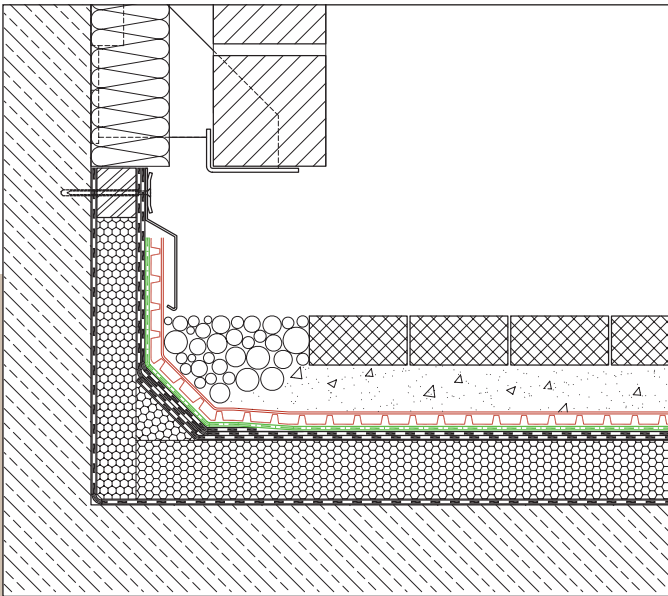
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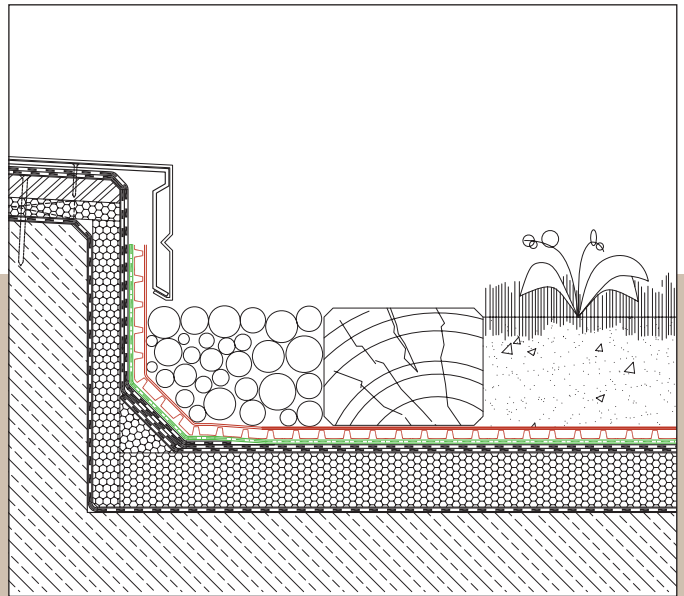
*Herbaceous roof detail – connection to a door with an outside step.
Splash guard height: 15 cm.*



Herbaceous roof detail – roof drain connection.



Herbaceous roof detail – connection to a double-shelled masonry structure.



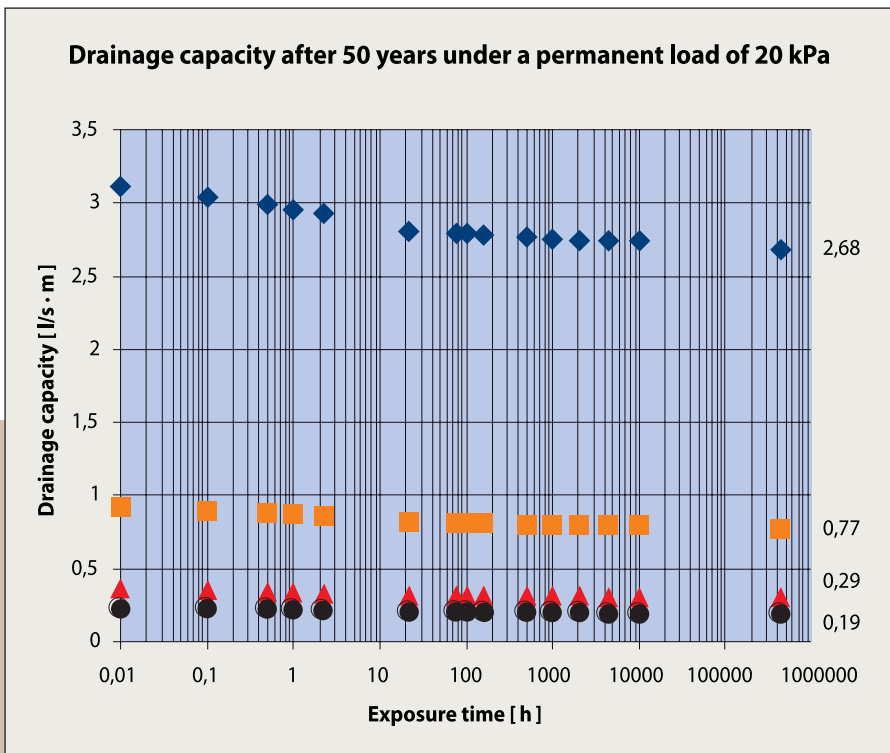
Herbaceous roof detail – fascia with metal cover.

Certified Safety under Permanent Loading

To judge which drainage system is suitable for a certain application, it is crucial to consider not only its vertical but also its horizontal drainage capacity. All commercial drainage elements undergo compression over time to an extent that depends on the nature of the system and the structure. At all events, planners must feel certain that the drainage system selected will remain functional over prolonged periods, and that its safety is documented.

For this reason, the creep strength of DELTA[®]-TERRAXX was investigated by a reputable material testing institute to see how their drainage capacities are modified by exposure to a permanent load of 20 kN/m² over a period of 50 years. The result is highly convincing: In vertical application, the drainage sheets display an outstanding drainage capacity of 3.1 l/s · m on installation, which diminishes only slightly to 2.68 l/s · m after 50 years' exposure to a load of 20 kN/m². Laid out horizontally under a burden of 20 kN/m², the performance of the two sheets is no different:

Installed on a gradient of 10 %, their initial drainage capacity is 0.91 l/s · m, declining to 0.77 l/s · m after 50 years. On a 2 % gradient, their drainage capacity amounts to 0.35 l/s · m on installation, dwindling only minimally after 50 years to 0.29 l/s · m, ten times the value specified in the drainage standard DIN 4095, which is 0.03 l/s · m. The conclusion is that DELTA[®]-TERRAXX offer a maximum of security to planners, owners, and tradesmen.



◆ Vertical installation ■ 10 % gradient ▲ 2 % gradient ● 1 % gradient

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Fast and Easy Installation

DELTA®-TERRAXX can be laid out quickly, safely, and cost-efficiently straight from the roll. Sheets are simply rolled off on top of the waterproofing, with the permanent-filtration geotextile always facing up. The roofing membrane manufacturers should be consulted about whether or not separation/slip sheets are required. One roll yields 30 m² of high-performance drainage in a single pass. The time required for laying amounts to no more than one minute per square metre. The drainage sheet should cover the entire waterproofing layer as well as the foot of any vertical element, such as a parapet or a wall. Exposed vertical surfaces should be protected from mechanical influences by sealing lips or similar accessories.

Finishing comes easy even where details are concerned. In the overlap zones, one edge of the sheet is free of dimples and equipped with a self-adhesive strip. To join a sheet to its neighbour, you merely need to lift up the geotextile and push the adjacent sheet underneath it. Then, you pull off the liner that covers the adhesive tape and glue the two sheets together. Once this is

done, the sheets can no longer shift, and their edges cannot be raised up by wind. Immediately after laying, the drainage sheets will easily bear the weight of a wheelbarrow or even a wheeled loader when covered with made ground, which should be at least 20 cm thick for a wheeled loader.

To bear the weight of a vehicle, the made ground should have the minimum thickness listed below:



Vehicle type	Car	Truck 3/3	Truck 6/6	Truck 9/9	Truck 12/12	Truck 16/16	Heavy truck 30	Heavy truck 45	Heavy truck 60
Contact area width [m]	0,20	0,20	0,20	0,26	0,30	0,40	0,40	0,50	0,60
Maximum wheel load [kN]	4,5	10	20	30	40	50	50	75	100

Required thickness for unbound base courses (crushed stones, gravel) [m]									
DELTA®-TERRAXX	0,05	0,09	0,19	0,24	0,28	0,30	0,30	0,40	0,45

Required thickness for bound base courses (casted concrete) [m]									
DELTA®-TERRAXX	0,05	0,05	0,11	0,15	0,18	0,19	0,19	0,26	0,30



Technical Data

Dimpled drainage sheets:	
Dimpled sheet	HDPE silver
Filter cloth	PP grey
Flat edge/self-sealing overlap edge	Yes/yes
Dimple height	ca. 9 mm
Air gap	ca. 7,9 l/m ²
Contact area dimples/ground	ca. 8.000 cm ² /m ²
Compressive strength (transient loading)	ca. 400 kN/m ²
Compressive strength (permanent loading)	ca. 90 kN/m ²
Installation depth	10 m
Service temperature range	- 30 °C to + 80 °C
Tensile strength	6,0 kN/m (EN ISO 10319)
Dynamic perforation resistance (Cone drop test)	40 mm (EN 918)
Opening size O90	150 µm (EN 12956)
Roll size	12,5 m x 2,4 m

Hydraulic properties:		
Drainage capacity without loading in l/s · m		
i = 0,02	0,40	
i = 0,03	0,51	
i = 0,10	1,03	
i = 1,00	3,50	
Drainage capacity with 20 kN/m ² load in l/s · m		
i = 0,02	0,32	
i = 0,03	0,42	
i = 0,10	0,84	
i = 1,00	3,10	

Durability: To be covered within 2 weeks after installation. No deterioration after 25 years in natural soil having a pH value between 4 and 9 and a temperature of < 25 °C.

Accessories: DELTA®-DRAINAGEVLIES separation and filter cloth to ensure the filtration function of drainage systems.

Tender Specifications

DELTA®-TERRAXX on horizontal waterproofing Two-ply protection and drainage system featuring a self-adhesive edge (made by Dörken GmbH & Co. KG, D-58311 Herdecke), to be delivered and expertly installed.

Consult the roofing sheet manufacturer about separation layers and slipsheets.

Building height: ... m above ground.

Sheets shall be laid out in conformance with the manufacturer's instructions. Sheet overlaps must be adequate. Overlaps should be held together by the integrated self-sealing edge. The permanent-filtration geotextile must face the soil.



DELTA®-Information

about protection and drainage systems for different applications.

Technical planning

Valuable explanations about how the various DELTA®-Systems may be used to protect buildings, cellars, underground parking lots, and tunnels effectively from damp and water.



Planning information for flat-roof systems

A wealth of information about extensive and intensive herbaceous covers as well as walkable and driveable standard and inverted flat roofs.



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