NOPHADRAIN®

GREEN ROOF INNOVATORS

SYSTEM OVERVIEW

0.1

UTILITY ROOFDECKS
GREEN ROOFS
PODIUM ROOF DECKS
PARKING ROOF DECKS

1 MAXIMIZE THE OPEN SPACE

The use of a roof in itself is nothing new. As early as 1926 the roof of the Fiat factory in Lingotto (Italy) was designed as an automobile testing circuit by the Italian engineer Mattè-Trucco. This utility roof deck, described by Le Corbusier as "one of the benchmarks of modern technology", had been made possible by the invention of reinforced concrete. In the past, roofs were often used for aesthetic reasons and to show technical feasibilities; nowadays the use of a roof deck is seen as a functional way to maximize open space. This so-called "multiple" or "stacked" use of open space is seen in many of today's designs by architects and urban planners.

Due to the design brief and/or local building regulations open space is often reduced to a multi-colour mosaic of cars parked on a closed, heat-reflecting surface. Underground parking garages offer an economic and practical solution, allowing the roof deck of the sub-structure to be covered with extensive and/or intensive planting schemes that can be combined with suitable hard landscaping to provide access for pedestrians and/or vehicular traffic.

As a specialist in the field of innovative green roof, podium roof deck and parking roof deck systems, Nophadrain provides that essential bridge between the various disciplines in design and development. The aim is to create a balance between possibilities and necessities in the use of stacked open spaces. Opportunities are seized and optimized while risks are eliminated or minimized as far as possible.

2 UTILITY ROOF DECKS

A carefully designed and well-planned utility roof deck creates a durable solution to the problem of making the most of the available open space, whilst simultaneously promoting economic growth and creating desirable living conditions. Depending on the design, the required functionality, and the maximum allowed roof deck load, Nophadrain offers systems that enable the design of roof decks with soft and hard landscaping accessible to pedestrians and vehicular traffic.

Extensive green roofs

An extensive green roof is a completely natural form of roof covering that uses a carefully considered combination of hardy, drought resistant plants, such as succulents (Sedum), along with herbaceous perennials and grasses. This type of vegetation is self-regenerating, predominantly low-growing, that acts as a natural blanket for the waterproofing system, and exhibits a high degree of adaptability to survive in relatively extreme climatic conditions (drought, sun, wind, frost). The types of plants that are used for extensive green roofs make comparatively modest demands on the layer configuration, and so the overall weight, the build-up depth, and the loading of the extensive green roof are relatively small.

An extensive green roof is chosen primarily for aesthetic reasons and as such, is not designed to be walked upon, except for occasional maintenance and control purposes. In addition, extensive green roofs can contribute to storm water management by reducing the quantity and the speed of rainwater discharge to the storm water system.

For the design of extensive green roofs, Nophadrain has developed the Extensive Green Roof System.

Intensive green roofs

Intensive greening of a roof can be considered as comparable to more traditional soft landscaping schemes in terms of potential use and diversity of design. Planting can include lawn, shrubs, bushes and even the occasional tree. Once planted, the vegetation imposes a fairly high demand on the composition and layer thickness of the growing medium. Intensive green roofs blend in with the surroundings as they are mostly installed at ground level on top of a sub-structure as a part of a wider soft landscaping scheme installed around buildings.

Intensive green roofs have a much greater effect on the climate than extensive green roofs. Due to their thicker layers and their intensive planting schemes, intensive green roofs are more effective in reducing levels of greenhouse gases, as well as improving air quality, rainwater management and the bonding of small dust particles.

The Nophadrain Intensive Green Roof System offers the perfect solution for the design of intensive green roofs.

2 UTILITY ROOF DECKS

Podium roof decks – Parking roof decks

Not only can roof decks be covered with soft landscaping, they can also be hard-landscaped. This ability to combine hard and soft surfacing make it possible to continue the existing scenery of the surroundings around buildings on top of sub-structures. In addition, designers can create more parking spaces or use the roof deck as a public space for organising informal markets, local festivals, and such. In order to allow emergency services access to the roof deck, the paving needs to be designed to carry both the static and dynamic loading of vehicular traffic.

For podium and parking roof decks, Nophadrain has developed the Podium Deck System, the Parking Deck System-Cars and the Parking Deck System-Trucks.

The Nophadrain Systems

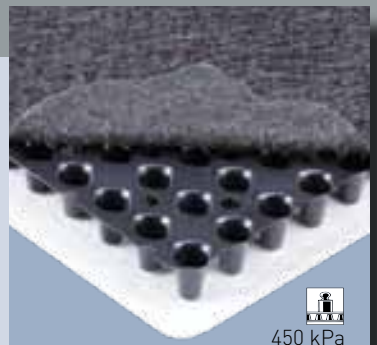
A properly functioning drainage layer that has been specifically selected for optimal performance is an essential component of every well-designed utility roof deck. Nophadrain provides a range of systems with guaranteed durability and functionality which is achieved by careful fine-tuning of the various build-up layers.

All Nophadrain green roof systems, whether they are intensive or extensive systems, incorporate a build-up structure that replicates a natural soil profile and thereby creates a stable and natural growing environment for the planting scheme. The Nophadrain Podium Deck and Parking Deck systems provide secure protection of the waterproofing system and provide a stable, reliable and durable sub-layer for both pedestrian and trafficked paving.

3.1 THE CORE OF THE SYSTEMS

ND 4+1 high Drainage Composite

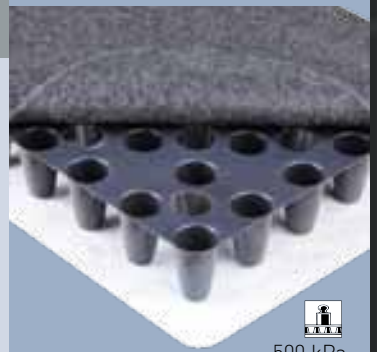
- Thickness approx. 17mm
- Non-woven filter fabric
- Protection and separation fabric
- Core is perforated for drainage and moisture diffusion
- Water reservoir approx 4.4l/m²
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked



450 kPa

ND 5+1 Drainage Composite

- Thickness approx. 27mm
- Non-woven filter fabric
- Protection and separation fabric
- Core is perforated for drainage and moisture diffusion
- Water reservoir approx 5.8l/m²
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked



500 kPa

ND 6+1 Drainage Composite

- Thickness approx. 27mm
- Non-woven filter fabric
- Core is perforated for drainage and moisture diffusion
- Water reservoir approx 8.0l/m²
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked

300 kPa

4 APPLICATIONS

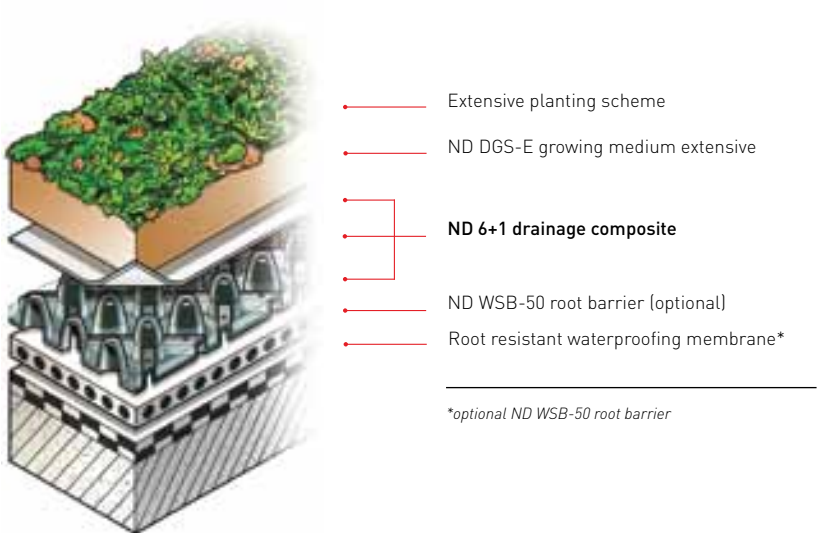
Type of ND Drainage Composite	ND 4+1 high	ND 5+1	ND 6+1	ND 200 - ND 220	ND 200s - ND 200sv	ND 600 - ND 620	ND 620hd	ND 600s - ND 600sv	ND 600hdsv
Extensive green roofs	■	■	■	■					
Extensive green roofs (inverted roof)	■	■	■						
Extensive green roofs (pitched roof)				■					
Intensive green roofs	■	■	■	■		■	■		
Intensive green roofs (inverted roof)	■	■	■					■	■
Podium roof decks	■	■	■	■		■	■		
Podium roof decks (inverted roof)	■	■	■		■			■	■
Parking roof decks - car						■	■		
Parking roof decks - car (inverted roof)								■	■
Parking roof decks - truck							■		
Parking roof decks - truck (inverted roof)									■

5.1 EXTENSIVE GREEN ROOF SYSTEM

The Nophadrain Extensive Green Roof System is designed for extensive planting schemes. The core of the system is the ND 4+1 high Drainage Composite. This multifunctional CE marked drainage composite ensures rapid removal of excessive precipitation, protecting the root resistant waterproofing membrane against mechanical damage. The dimples create an additional water reservoir for the vegetation. For roofs with insufficient falls, the ND 5+1/ ND 6+1 is installed with a dimple height of 26mm.

The Nophadrain Extensive Green Roof System has a small build-up height, starting at just 70mm thick, and weighing-in at approx. 100kg/m². The weight of the system can be reduced by replacing the growing medium by the specially-developed ND SM-50 Growing Medium Panels. This Nophadrain Lightweight Green Roof System reduces the total weight of the system to approx. 50kg/m².

For more detailed information, please refer to the Nophadrain "Design and Installation Manual Extensive green roofs".

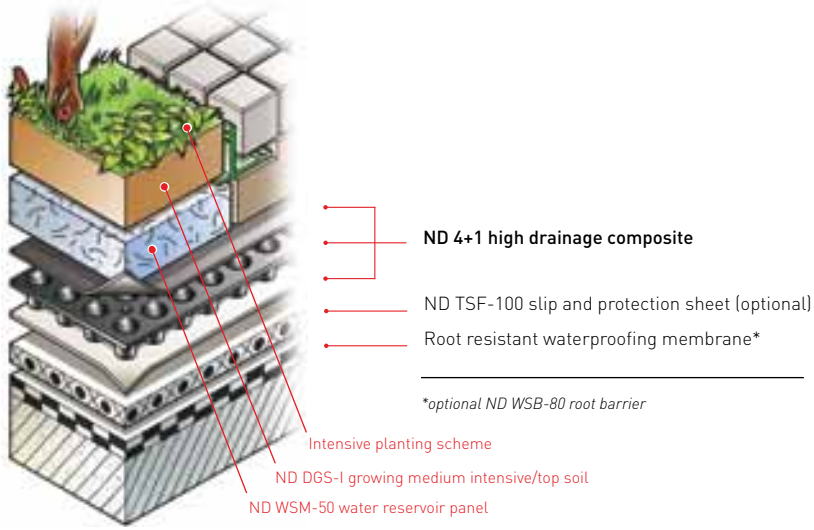


5.2 INTENSIVE GREEN ROOF SYSTEM

An intensive planting scheme has a high demand for water. In the Nophadrain Intensive Green Roof System water is stored in the ND WSM-50 Water Reservoir Panels and made available to the plants in a natural way. In addition, these panels create a pre-filter when top soil is used as a growing medium layer instead of the substrate.

The water reservoir panels are placed directly on top of the CE marked ND 4+1 high Drainage Composite. Once the ND WSM-50 Water Reservoir Panels are saturated, the excess water is discharged via the drainage composite to the roof outlets. The drainage composite prevents the build-up of water in the growing medium layer. The ND 4+1 high Drainage Composite has a high compressive strength (>400kPa) and can withstand the high stresses imposed by an intensive green roof build-up. The ND TSF-100 Slip and Protection Sheet is installed between the drainage composite and the waterproofing membrane and protects the waterproofing membrane permanently against mechanical damage.

For more detailed information, please refer to the Nophadrain "Design and Installation Manual Intensive green roofs".



5.3 PODIUM DECK SYSTEM

Pedestrian paving can be installed on a podium deck with the Nophadrain Podium Deck System. The CE marked ND 220 Drainage Composite forms the heart of the system and ensures a rapid discharge of excessive precipitation. The flexible paving is placed on a laying course or levelling layer directly on top of the ND 220 Drainage Composite. To prevent damage to the waterproofing due to static and dynamic loading, a slip layer is installed consisting of the ND 220 Drainage Composite and the ND TGF-20 Slip Sheet, or at high loadings the ND TSF-100 Slip and Protection Sheet. Thanks to the excellent drainage capacity of the ND 220 Drainage Composite, the Nophadrain Podium Deck System prevents damage to the paving during periods of frost. The Nophadrain Podium Deck System can easily be combined with intensive planting schemes.

For more detailed information, please refer to the Nophadrain "Design and Installation Guide Podium roof decks Parking roof decks".

Flexible paving

Laying course

ND 220 drainage composite

ND TGF-20 slip sheet*

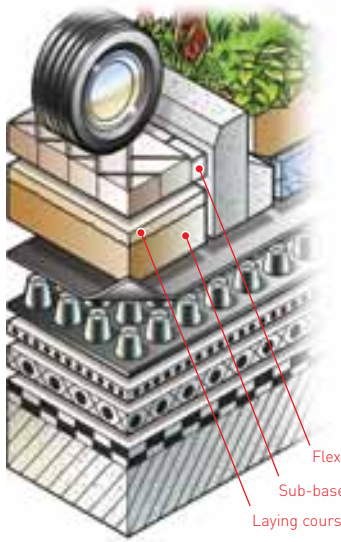
Waterproofing membrane

**optional ND TSF-100 slip and protection sheet*

5.4 PARKING DECK SYSTEM–CARS

Trafficked paving on roof decks requires an engineered build-up to prevent the extreme vehicular traffic loadings causing damage to the roof deck construction and the waterproofing membrane. The traffic loadings are absorbed by the Nophadrain Parking Deck System-Cars by the ND TSF-100 Slip and Protection Sheet in combination with the high pressure resistant CE marked ND 620 Drainage Composite. The drainage composite ensures excellent drainage of the sub-base and prevents lifting of the road surface by frost and rutting. The high compressive strength of the ND 620 Drainage Composite (>900 kPa) and the special woven filter fabric make it possible to compact the sub-base layer in accordance with best practice guaranteeing stability of the paving elements. The Nophadrain Parking Deck System-Cars has been assessed by both index and performance tests. The parking deck system can be easily combined with intensive planting schemes.

For more detailed information, please refer to the Nophadrain "Design and Installation Guide Podium roof decks Parking roof decks".



ND 620 drainage composite

ND TSF-100 slip and protection sheet

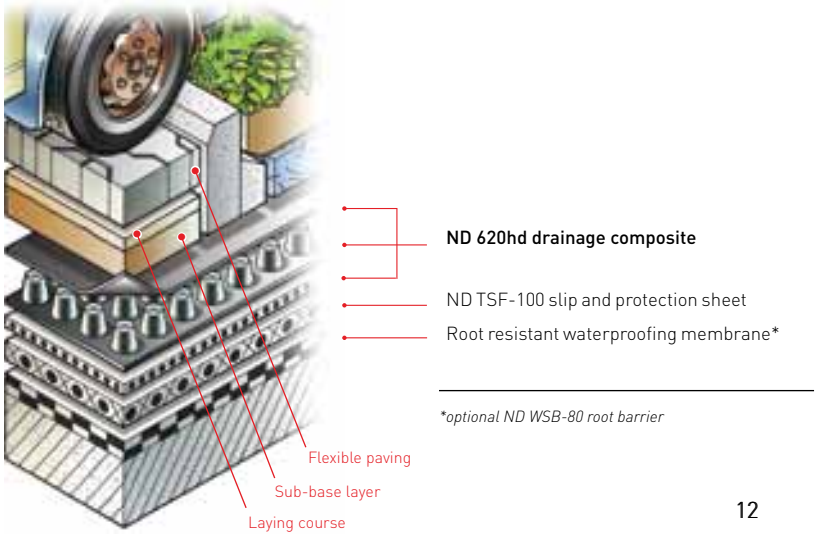
Root resistant waterproofing membrane*

**optional ND WSB-80 root barrier*

5.5 PARKING DECK SYSTEM–TRUCKS

The Nophadrain Parking Deck System-Trucks has been extensively subjected to performance tests by the Technical University in Munich. In particular, loading areas for trucks and emergency vehicles zones (fire engines, ambulances, etc.) are exposed to high dynamic and static (traffic) loads. The pressure resistant CE marked ND 620hd Drainage Composite (>1,200kPa) in combination with the ND TSF-100 Slip and Protection Sheet offer an excellent protection for the waterproofing membrane. The sub-base layer, which is installed directly on top of the drainage composite, can therefore be compacted properly creating a suitable base for the paving elements. The parking deck system can be easily combined with intensive planting schemes.

For more detailed information, please refer to the Nophadrain "Design and Installation Guide Podium roof decks Parking roof decks".



ND 620hd drainage composite

ND TSF-100 slip and protection sheet

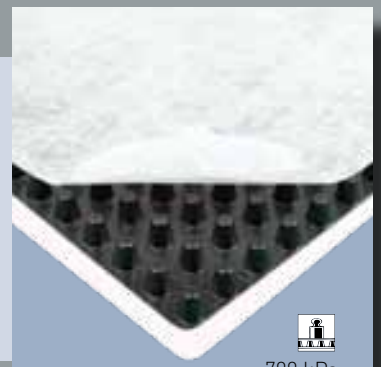
Root resistant waterproofing membrane*

**optional ND WSB-80 root barrier*

3.2 THE CORE OF THE SYSTEMS

ND 200/220 Drainage Composite

- Thickness approx. 13mm
- Non-woven filter fabric
- Pressure dividing slip film (type ND 220)
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked



700 kPa

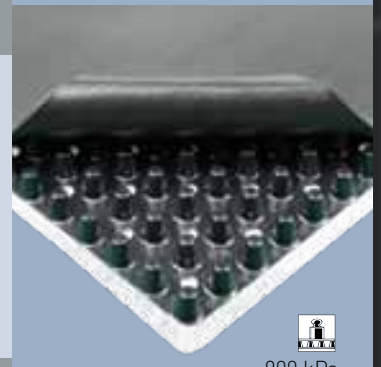
ND 600/620 Drainage Composite

- Thickness approx. 13mm
- Woven filter fabric
- Pressure dividing slip film (type ND 620)
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked
- Type hd has a compressive strength of >1,200kPa

900 kPa

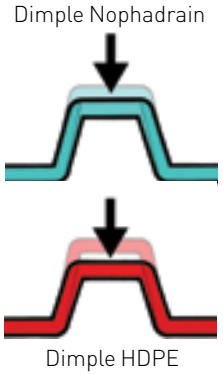
ND 600s/ND 600sv Drainage Composite

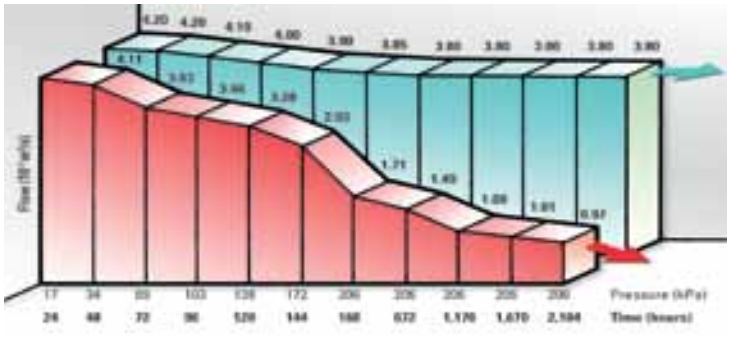
- Thickness approx. 13mm
- Woven filter fabric
- Protection and separation fabric (type ND 600sv)
- Core is perforated for moisture diffusion
- Drainage complies with BS EN ISO 12958
- Protection complies with DIN 18531
- CE marked
- Type hd has a compressive strength of >1,200kPa



900 kPa


Research and development
Manufacturing process and dimple design
Within Nophadrain, research is a continuous proces.Close cooperation with technical universities allows research to be undertaken regarding the durability of the Nophadrain systems by means of performance testing on the build-up of trafficked roof decks, index tests to assess the efficiency of protection layers at heavy loadings (traffic loads), and practical research on the filter stability of woven and non-woven filter fabrics.
1.2.1.4
Geocomposite (GCO)
Manufactured, assembled material using at least one geosynthetic product among the components
CE marking - BS EN 13252





New dimple design,
upto 80% stronger

6 INNOVATION AND DURABILITY

Research and development

Within Nophadrain, research and development is a continuous process. Using the latest CAD software, new high-compressive dimple shapes are designed and tested. Close cooperation with technical universities allows research to be undertaken regarding the durability of the Nophadrain systems by means of performance testing on the build-up of trafficked roof decks, index tests to assess the efficiency of protection layers at heavy loadings (traffic loads), and practical research on the filter stability of woven and non-woven filter fabrics.

Deliberate choice of materials – HDPE versus HIPS

Nophadrain uses high impact polystyrene (HIPS) as the base material in the ND Drainage Composites because this material has excellent creep resistance when put under pressure over an extended period of time. This is the outcome of a number of tests performed on drainage composites made of HIPS and polyethylene (HDPE). The graph shows that drainage composites made out of HDPE experience serious creep from the start of the test. Within three months, the system loses 79% of its original drainage capacity. The Nophadrain system shows an excellent resistance against creep and maintains its drainage capacity.

Manufacturing process and dimple design

The manufacturing process developed by Nophadrain guarantees a constant wall thickness of each dimple. Combined with the conical dimple geometry, the drainage composite achieves a high compressive strength to resist the shear forces caused by backfill and soil settlement. The geometric placement of the dimples provides an unobstructed water flow and allows easy installation of the drainage composite.

CE marking – Construction Product Directive 89/106/EC

Within the EC it is forbidden to release a construction product onto the market if the product is not CE marked based upon the Construction Product Directive 89/106/EC. Geotextiles and geotextile-related products such as drainage composites (GCO) and geospacers (GSP)* have to be CE marked (BS EN 13252). All Nophadrain ND Drainage Composites are CE marked.

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* *a three-dimensional polymeric structure designed to create an air space in the soil and/or other materials in geotechnical and civil engineering application (BS EN ISO 10318).*

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