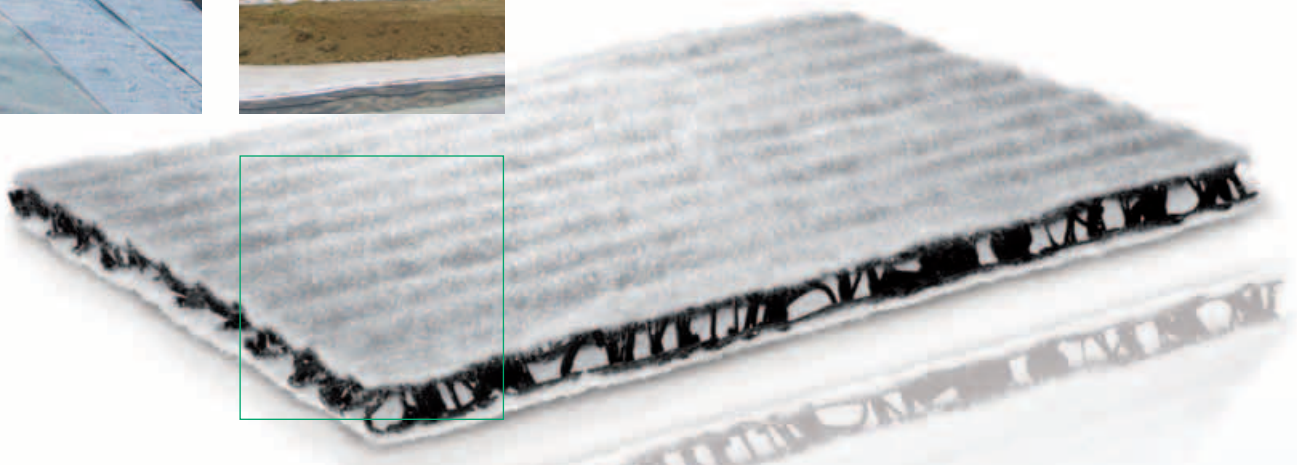
Advantages of Secudrain® drainage systems

- filtration, protection and drainage in one product
- excellent in-plane flow properties
- long-term hydraulic performance
- replaces natural drainage aggregate
- very high creep resistance
- resistance to chemical and biological degradation
- perfectly suited for steep slope application due to very good shear properties
- robust against on-site conditions
- quick and cost-effective installation
- highest quality control standards
- ISO 9001 certified
- CE marked



NAUE

Secudrain® WD

Secudrain® WD is a 1.90 m or 3.80 m wide three-dimensional geosynthetic drainage system. It consists of a strong and stable drainage layer (wave-structured monofilament core) and at least one needle-punched Secutex® separation/filtration nonwoven geotextile which is firmly connected to the drainage core creating a high shear stress transfer.

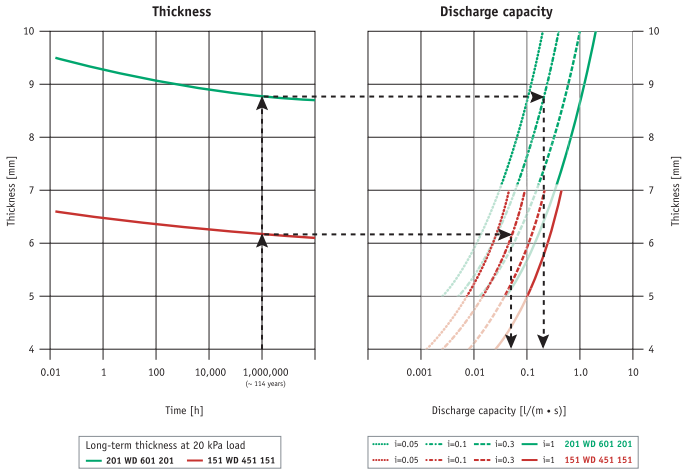
Secudrain® WD drainage systems are used in geotechnical applications to directly replace conventional granular fill. Secudrain® efficiently collects and drains away precipitation or groundwater. Typical applications are:

- liquid or gas collection in landfills
- drainage of structures or buildings
- surface drainage under transportation infrastructures
- drainage of roofing areas

Advantage: High drainage performance

Secudrain® is used for the drainage of areas or structures which are in contact with soil, including excavation backfill. It will discharge percolation water, thereby reducing the hydrostatic pressure on the structure and its sealing system. Due to the high void ratio of the drainage core (at least 95 %), Secudrain® has a high water discharge capacity in all directions. Secudrain® flow capacities are determined based upon the thickness expected under the specific confining stress, which can be correlated to long-term laboratory test results. Therefore, no special reduction factors are required in the drainage calculations (see NAUE Civil Engineering brochure). The evaluation graph in figure 1 provides realistic water drainage capacity figures for assessment purposes. Its accuracy is much better than other common methods in which short-term water drainage capacity is simply reduced.

Fig 1
Design chart to determine the water discharge capacity of Secudrain® WD as a function of the long-term thickness



Advantage: High compressive stability

The wave structured drainage mat Secudrain® WD ensures a long-term stability not only against horizontal but also against inclined compressive forces (also known as creep), which is achieved by the stable three-dimensional arch of the wave drain structure.

An important design property of any geosynthetic drainage mat is its ability to withstand compressive loads, such as the weight of cover soil or waste, without being compressed and losing its flow capacity. With the long-term Secudrain® pressure-creep-curves (Fig. 2) and the correlating discharge capacities (Fig.1) for the selected long-term thickness a 1.0 reduction factor (RF) can be assumed for the calculation of the long-term Secudrain® drainage design value.

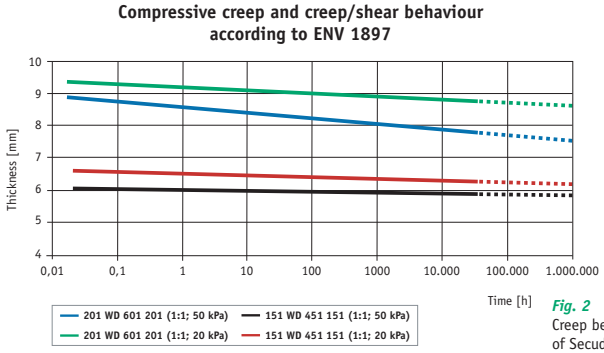


Fig. 2
Creep behaviour of Secudrain®

The total long-term water outflow Qlong-term expected from Secudrain® is then calculated from the laboratory determined drainage capacity Qlab,i=1,σ, the slope inclination (β) and the total reduction factor (ηtotal). With the project specific data our NAUE team can recommend Secudrain® typical reduction factors for a first design assessment.

$$Q_{long\text{-}term} = Q_{lab,i=1,\sigma} \bullet \sin\beta / \eta_{total}$$

$$\eta_{total} = RFIN \bullet RFCR \bullet RFCC \bullet RFCB \bullet RFSY$$

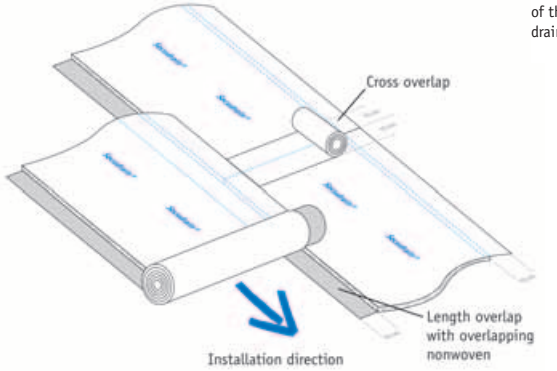
RFIN = for installation damage
RFCR = for creep deformation
RFCC = for chemical degradation
RFCB = for biological degradation
RFSY = for typical system faults

Advantage: Quick and easy installation

The 1.90 m or 3.80 m wide and typically 35 m or 70 m long Secudrain® rolls are quick and easy to install - filter, drainage and protection layer comprised in one unit. The pre-manufactured overlap configuration of Secudrain® provides a simple and quick butt jointing of the panels in the longitudinal direction (see Fig. 3). This structure ensures the continuous discharge of water within the drainage core. In the transverse direction the panels are simply overlapped. If required, the flexible, multi-functional drainage material can accommodate corners, edges and complicated geometric structures without impacting the performance characteristics and can easily be fixed to different structures.

The use of Secudrain® in earth construction requires less excavation of in-situ material and, in the case of a landfill liner, the containment volume is increased. Using Secudrain® saves time and natural resources since 10,000 m² of the Secudrain® system can replace the extraction, transport, and installation of approximately 3,000 m³ of granular drainage material. Secudrain® keeps the costs lower than conventional methods and can be installed in most weather conditions.

Fig. 3
Longitudinal and cross overlapping of the Secudrain® drainage system



APPLICATION

VERTICAL DRAINAGE ON A CONCRETE CAISSON WALL

The B 239 Herford, Germany, bypass to the state highway A2 was planned and put out for tender by the responsible state highway authority. The contract was awarded to a joint venture between Bickhardt Bau AG and Bickhardt Bruecken- und Ingenieurbau GmbH in Kirchheim, Germany. The job involved building a bridge across the B 239. Prior to commencing construction of the bridge abutments, a bored concrete caisson wall was erected. The design also provided for the installation of a drainage layer between the concrete caisson wall and facing for the bridge abutment and on the wing walls. The selected drainage material had to follow German requirements, asking for a water discharge capacity of > 0.3 l/s • m under the respective earth pressure. The decision was finally taken to install the geosynthetic drainage system Secudrain® produced by NAUE GmbH & Co. KG, a three-dimensional drainage system consisting of a stable, pressure-resistant, wave-shaped drainage core encapsulated between two filter nonwoven geotextiles. The high compressive stability of the drainage core ensured the required drainage discharge capacity of > 0.3 l/s • m at the design depth of 12 m. In addition, the selected Secudrain® met all other requirements:

- high weather resistance
- effective nonwoven geotextile apparent opening size of 0.07 mm to 0.2 mm
- water permeability of the filter nonwoven geotextiles 100 times higher than that of the soil.

As Secudrain® is easy to handle and install, it was possible to install the drainage layer section for section as the concrete levelling layer was poured. Secudrain® was faced against the bored concrete caisson wall and spot-fixed using shot-anchors. The cavities were then filled with concrete prior to installing the pre-fabricated facing elements. The use of 1,500 m² of Secudrain® on the bridge abutments of the B 239 Herford bypass is now ensuring the long-term and controlled drainage of any water before it reaches the structure. Secudrain® provides a cost-effcient solution which would not have been possible using conventional granular materials, as well as a simple and save installation even on complicated construction shapes.

Fig. 4 Concrete was used as a level regulating course

CAPPING OF PÄÄSKÜLA LANDFILL

The largest landfill in Estonia, Pääsküla, just outside the capital city Tallinn, was capped in 2005 with the work finished in 2006. Although parts of the landfill had been in place for many years, substantial settlements were expected. This was confirmed by on-site measurements during the capping operation. The original design was based on a soil-gas-drainage layer, a geosynthetic clay liner (GCL), a gravel-rainwater drainage layer and a top layer of soil, thickness 1 m. Because of the expected settlement a flexible but robust Bentofix® B 4000 GCL was selected. During the operation the contractor had issues in sourcing the right quality of gravel for the rainwater drainage layer so it was decided that this drainage layer would be replaced by Secudrain® 151 WD 501. The geosynthetic consultant BBG was able to show the supervising engineers that Secudrain® could outperform the original specified gravel layer. The main contractor for this capping project was Skanska's Estonian company. The installation of the Bentofix® and Secudrain® was carried out by the NAUE agent in Estonia, Via Con Eesti. The supervisors for this project were C + E from Chemnitz, Germany.

Fig. 5 Secudrain® drainage mat installed over Bentofix®

INSTALLATION

Secudrain® storage

Unrolling of Secudrain®

Product marking

Length overlaps

Thermal overlap fixing

Vertical installation of Secudrain®

Soil placement

Geosynthetic system solution

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