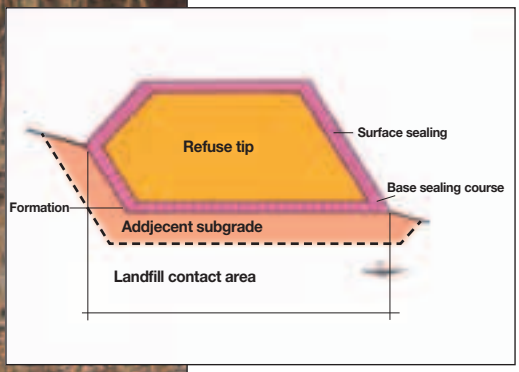
Landfill Construction

HUESKER

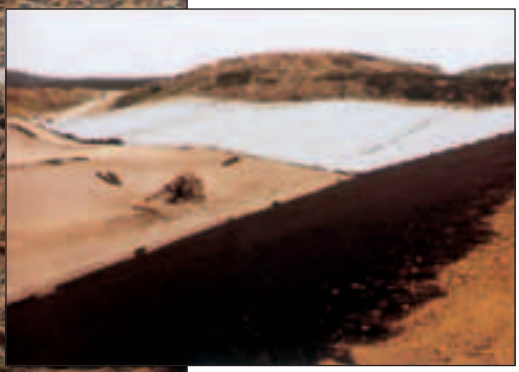
Engineering with Geosynthetics

Geosynthetics for landfill construction separate, protect, filter, drain, reinforce and seal

In recent years increased environmental awareness and the problems associated with waste disposal, such as the risk of groundwater contamination from leachate, have led to new technical developments in the construction of landfilis that are intended to reduce harmful environmental effects. Among others, the basic principle of the multi-barrier concept was developed which requires several impermeable barriers to render the landfill isolated from the environment.



The major elements of this concept are the landfill's base and surface sealing systems. Geosynthetics have now become an indispensable part of these sealing systems. For example, they separate the mineral sealing layer from subgrade or protect the geomembrane from damage. Geosynthetics are also used as filters between the refuse and drainage layer or to reinforce surface sealing and steep embankments. Composite geosynthetics with a high drainage capacity can even be used instead of mineral drainage layers. Geosynthetic Clay Liners (GCL) consisting of bentonite powder encapsulated between geosynthetic covering/carrier materials, can be used in sealing applications.



For all these different applications, a variety of geosynthetics are used:
- nonwovens
- wovens
- flexible geogrids
- composite geosynthetics
- geosynthetic clay liners

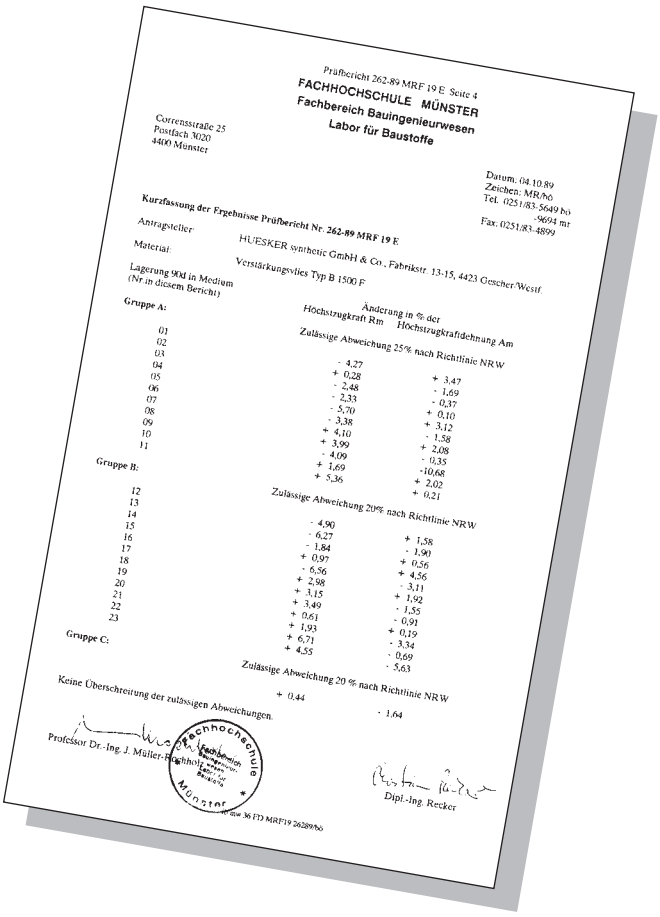
Selecting raw materials

In a landfill, geosynthetics can be subjected to enormous physical, mechanical, biological and chemical stresses. Selecting the appropriate geosynthetic is of great importance, particularly in view ot long-term chemical resistance.

The chemical with which geosynthetics come into contact in the landfill can be in liquid or gaseous form, highly concentrated or diluted. Due to the heterogenous composition, municipal waste for example, neither pure, highly aggressive substances nor even less aggressive, randomly mixed materials can be ruled out.

Today the recognised technical practice is to conduct chemical resistance tests on geosynthetics based on the chemical tests of the ”Guidelines for sealing the base of landfills with waterproof geomembranes” issued by the Regional Office for Water and Waste, North-Rhine Westphalia. The geosynthetics that HUESKER Synthetic provides for the construction of landfills are tested in accordance with these guidelines.

One could say that high density polyethylene (HDPE) geosynthetics may be used without reservation for resistance to chemicals. Polypropylene (PP) raw material only showed a change of just over 25% in mechanical properties when tested for resistance to highly concentrated, inorganic mineral acids. Combinations of the raw materials PP and HDPE can meet all the requirements of chemical resistance.



Prüfbericht 262-89 MRF 19 E Seite 4

FACHHOCHSCHULE MÜNSTER
Fachbereich Bauingenieurwesen
Labor für Baustoffe

Corrensstraße 25
Postfach 3020
4400 Münster

Datum: 04.10.89
Zeichen: MR/bö
Tel. 0251/83-5649 bö
-9694 mr
Fax: 0251/83-4899

Kurzfassung der Ergebnisse Prüfbericht Nr. 262-89 MRF 19 E

Antragsteller: HUESKER Synthetic GmbH & Co., Fabrikstr. 13-15, 4423 Gescher/Westf.

Material: Verstärkungsvlies Typ B 1500 F

Lagerung 90d in Medium
(Nr in diesem Bericht)

		Änderung in % der Höchstzugkraft Rm	Höchstzugkraftdehnung Am
Gruppe A:			
	01	- 4,27	+ 3,47
	02	+ 0,28	- 1,69
	03	- 2,48	- 0,37
	04	- 2,33	+ 0,10
	05	- 5,70	+ 3,12
	06	- 3,38	- 1,58
	07	+ 4,10	+ 2,08
	08	+ 3,90	- 0,35
	09	- 4,09	-10,68
	10	+ 1,69	+ 2,02
	11	+ 5,36	+ 0,21
Gruppe B:		Zulässige Abweichung 25% nach Richtlinie NRW	
	12	- 4,90	+ 1,58
	13	- 6,27	- 1,90
	14	- 1,84	+ 0,56
	15	+ 0,97	+ 4,56
	16	- 6,96	- 3,11
	17	+ 2,98	+ 1,92
	18	+ 3,15	- 1,55
	19	+ 3,49	- 0,91
	20	+ 0,61	+ 0,19
	21	+ 1,93	- 3,34
	22	+ 6,71	- 0,69
	23	+ 4,55	- 5,63
Gruppe C:		Zulässige Abweichung 20% nach Richtlinie NRW	
		+ 0,44	- 1,64
		Zulässige Abweichung 20 % nach Richtlinie NRW	

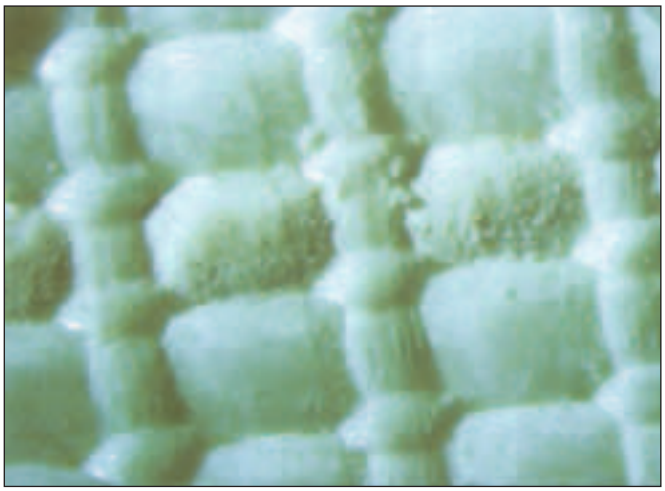
Keine Überschreitung der zulässigen Abweichungen.

Professor Dr.-Ing. J. Müller-Rochholz

Fachhochschule Münster

Dipl.-Ing. Recker

Anlage 36 FD MRF19 26289/b6



Formation of a natural filter with limited flushing out of fines

Geosynthetics in the base sealing system

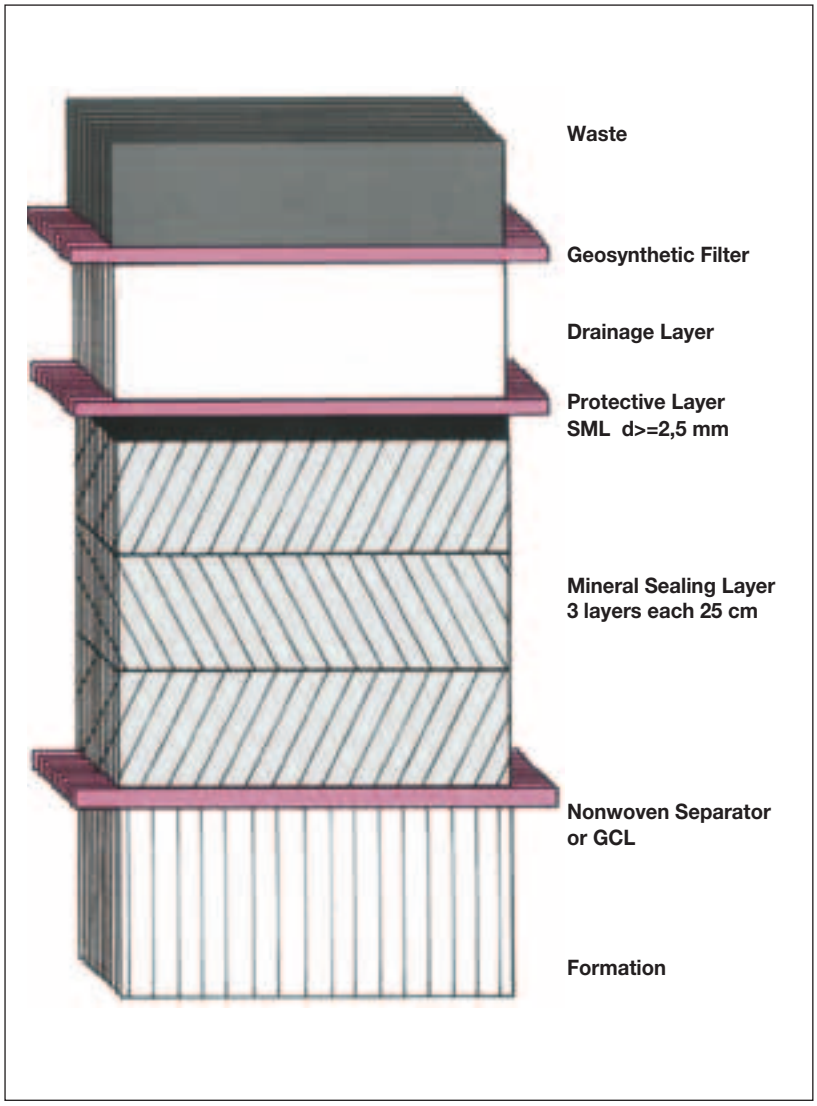
Geosynthetic Functions

A landfill's 5 base sealing course is specially important because it constitutes the most essential barrier for the protection of groundwater. There are two different types:
the purely mineral sealing System and the so called combined sealing which consists of a mineral sealing course with an additional waterproof geomembrane. The combined sealing is regarded as the best available technology both for special household and residual refuse tips.

Geosynthetics have a variety of uses in a combined sealing system:

- filtering between waste and the drainage layer
- protecting the waterproof geomembrane from mechanical damage
- channelling oft any seepage water that may escape or run oft siopes below the primary sealing course
- separating the mineral sealing layer from adjacent subgrade.

Furthermore, Geosynthetic Clay Liners (GCL) can be used to reduce water permeability and to increase the sorption potential of the formation.



Separating two layers

For separation one should preferably use nonwovens. Selection of the geosynthetic can be taken from section 7 of the Leaflet for the Use of Geosynthetics in Earthworks" by the German Research Association for Roads and Traffic. Major factors influencing selection of a geosynthetic tor this application are elongation, puncture strength, filter criteria and general suitability.
To ensure reasonable soil retention the apparent opening size should be less than 0.2 mm. A unit mass of at least 400 g/m^2 is recommended. HUESKER Synthetic offers a range of needlepunched nonwovens, which meet the above mentioned requirements.

Protecting the geomembrane

Proteotive layers have to safeguard the geomembrane reliably and permanently, e.g. pertoration by aggregate particles or from excess stress resulting in unacceptable strains. Some ot these stresses may arise when the drainage layer is installed or later caused by the increasing bad ot the refuse.

The short-term load effect from building up the drainage gravel can be simulated by construction tests on site. Such field trials using construction machinery and materials supplied by the contractor provide the opportunity to check the design of the protective System and minimise the impact on the geomembrane.

To test the long-term protective eftect of the nonwoven under heavy loading conditions, modified plate-loading tests are conducted in the laboratory following the regulations of the Federal Department of Material Research and Testing, Berlin. Laboratory tests are usually conducted under heavier static loads (at least factor 2), in order to obtain a safety margin. The test should be designed so that the protective efficiency ot the tested layer can be evaluated for the long-term basis.

The standard protection requires a needlepunched nonwoven with a unit mass of at least 1200 g/m^2 and a 15 cm thick layer of crushed aggregate (0 - 8 mm) on top ot the geomembrane. These two layers provide sufficient protective efficiency. When placing an aggregate drainage layer (16 - 32 mm). **HaTe®** reinforced nonwovens or other composites are often used to replace this standard protection, when specific site conditions are difficult for the installation.

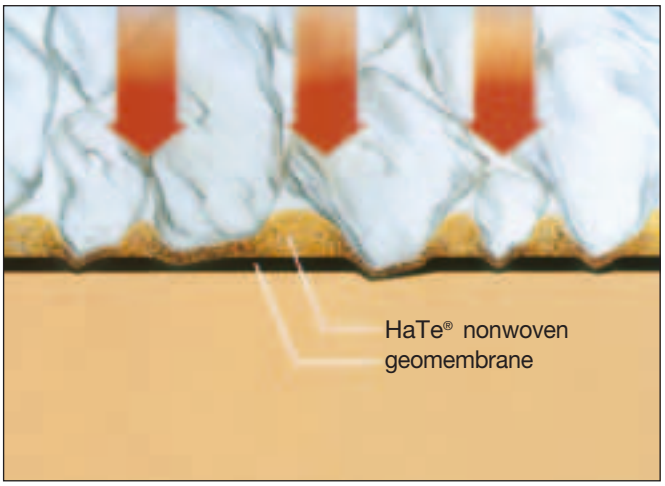
Protective layers for demanding situations

In order to provide effective protection of the geomembrane when using 16/32 mm drainage aggregate gravel of angular shape with heavy refuse loads, reinforced nonwovens are normally used. These composites consist of nonwovens reinforced either with fabric insert or by placing a rigid grid on top.

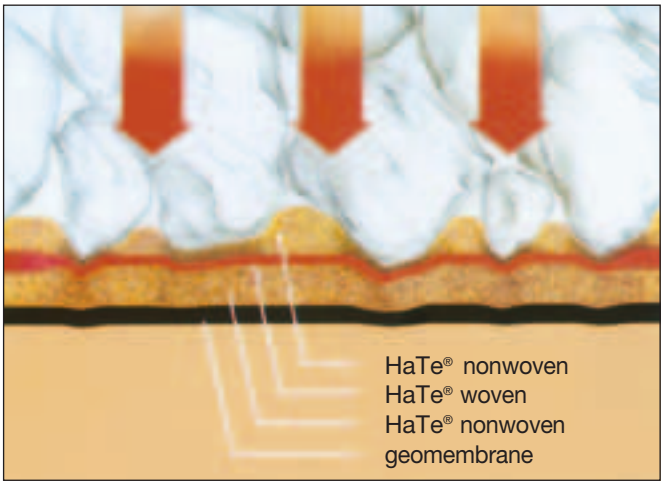
The protective effect of such reinforced nonwovens is based on two mechanisms: the nonwoven fibres envelop the individual aggregate particles, providing a cushioning from point loading. In addition, the individual particles, sinking into the nonwoven, tension the fabric, which in turn distributes the load.
Another advantage of **HaTe®** - reinforced nonwovens is that they will not - in comparison with normal nonwovens - be reduced in thickness when loaded by tensile stress - especially on steep slopes.

For extreme conditions, double layered wovens, acting as a formwork for mineral fill, can be used. Spacer threads hold both wovens together, the interposing space being filled with suitable material, such as a mixture of sand-bentonite or cement-mortar. After 1000 h elapsed testing time in a modified plate-loading-test with a normal pressure of 1500 kN/m² and drainage gravel, gradation 16 - 32 mm the max. local deformation of a HDPE geomembrane protected by the **Incomat®**-sandmattress reached a value of only 0,03%.

Apart from the excellent protective effect, reinforced nonwovens have another important advantage: they are simple and easy to install, providing an uniform, high quality.



Conventional protective nonwoven



Reinforced nonwoven

HaTe® B 2000 L after 1000 hour test

Capping systems

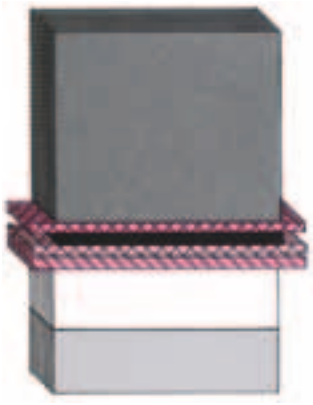
The landfill's capping System has two essential functions: it prevents gas escaping from the landfill into the atmosphere and surface water from penetrating into the body of the refuse tip. In addition, the soil above must be capable of recultivation.
The geosynthetics used have the same main functions as in the base seal. In addition, single elements like mineral gas drainage or the mineral drainage layer can be replaced by using drainage composites. Naturally these geosynthetics must meet the mechanical and hydraulic requirements. Moreover, they must be resistant to chemicals and gases, gas condensate and on occasions leachate.

As the top of the landfill may be subject to heavy mechanical loads from settlements of the body of the waste zone, it is advisable to use high strength geosynthetics for reinforcement.

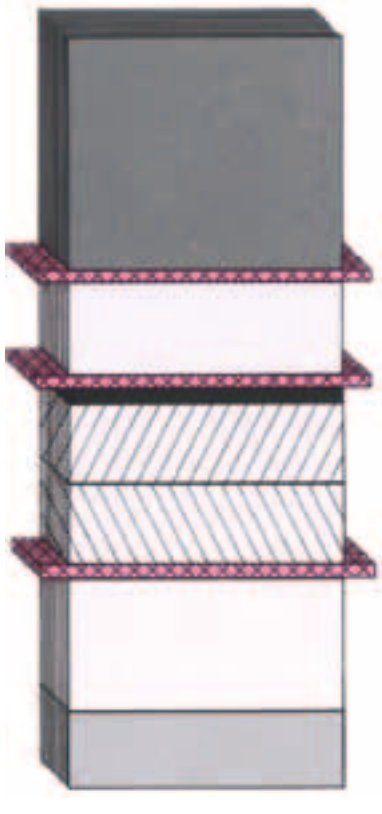
With **NaBento®** geosynthetic clay liner (GCL) conventional mineral lining can be replaced, being more reliable and economical.

The advantages are:

- NaBento® is a thin liner reducing earthworks and creating a larger volume for waste
- NaBento® installation is simple and in addition not weather dependant
- NaBento® is less critical to place than conventional mineral lining
- NaBento® is easily repaired if damaged
- NaBento®'s high internal shear value provides a stable lining on steeps slopes of up to 1 : 1.75 without failure in the bentonite liner
- NaBento® can be robustly joined with a special adhesive overlap, highly secure during construction and localised settlement
- NaBento® as a factory-made product is of a reliable and well-proven quality

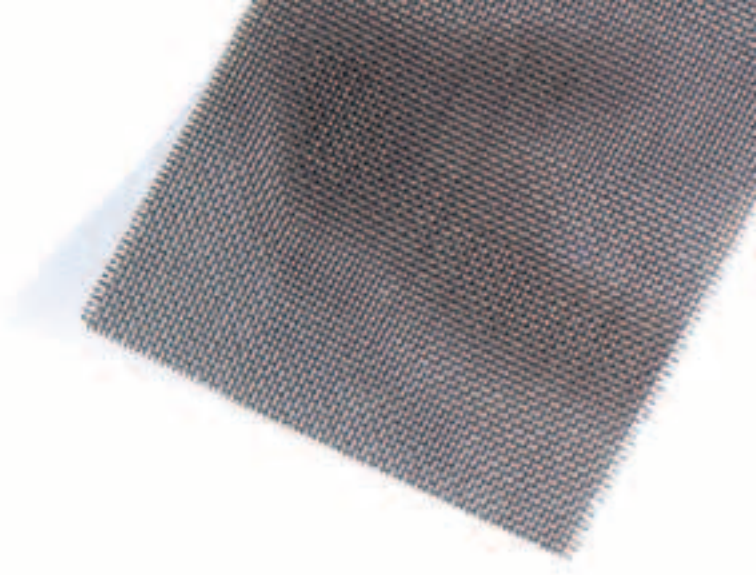


Capping system using geosynthetics



Capping system following German regulations

Geosynthetics for filtration and drainage



Woven and nonwoven filters

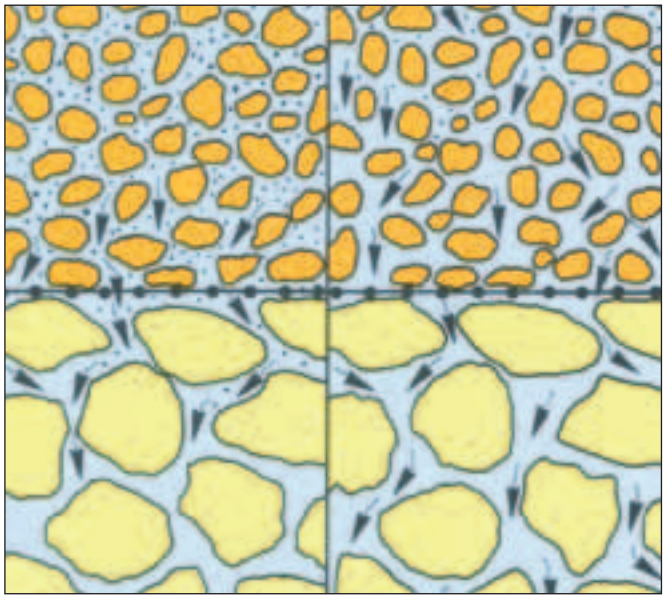
Geosynthetic filters in the base sealing have to prevent fine particles of refuse from infitrating the drainage layer. They are needed in the surface sealing as a filter layer between the base and the drainage layer or between the refuse and gas extracting layer. However, recent research showed that filter layers should not be installed where biological actions take place, because bacteriological growth tends to clog the filter. These filters are required to function on a long term basis.

Either woven or nonwoven filters can be used. Filters can be selected in accordance with the standard filter rules, e.g. ”Synthetics in Soil Mechanics and Hydraulic Engineering” by Working Group 14 of the German Association for Soil Mechanics and Foundation Engineering.

For municipal waste above a 16 - 32 mm drainage aggregate, to be effective, filters with opening between 0.4 and 1.0 mm are required. In order to comply with these special requirements, HUESKER Synthetic has developed both woven and nonwoven filters.

For preference woven filters should be used if a certain amount of fines migration into the drainage layer is acceptable. In this case, a natural filter occurs through erosion in the transition area of waste filter layer so that the filter fabric, in contrast to a nonwoven, does not become clogged.

HUESKER Synthetic manufactures various woven filters in mesh sizes ranging from 0.1 mm to 1.5 mm. By using monofilament yarns, the mesh opening can be designed as required.



Geosynthetics for drainage

It is often practical to replace mineral drainage layers for water or gases escaping from the landfill with geosynthetic drainage elements. This is particularly so in the case of engineering problems encountered when placing mineral drainage layers on steep slopes.

Composites of nonwovens and nets are available as geosynthetic drainage layers. The drainage core either consists of monofilaments or an extruded net. As encapsulating filter layers, thermally as well as mechanically-bonded, nonwovens can be selected.

Adequate, constant transmissivity must be ensured when selecting geosynthetic drainage composites. The specific project surcharge should be taken into account for evaluating the transmissivity.

Further technical information on the products mentioned and design of drainage composites can be obtained from HUESKER Synthetic.

Reinforcement with geosynthetics in landfill construction

Slopes and embankments frequently have to be reinforced with geosynthetics or geogrids to withstand tensile forces and to prevent cracks forming. Geosynthetic reinforcement can also be of practical use in landfills.

Reinforcement under the mineral base sealing layer

If local instability caused by soft ground or eroded subsoil is found when the subgrade is being levelled, it is advisable to use geosynthetic reinforcement under the mineral base sealing layer. High differential settlements and unacceptable strains can thus be avoided.

Temporary sealing layers

It is often necessary to guard against rainwater leaking into the refuse tip body with an interim sealing layer. However, there is a risk of cracking due to settlements of the refuse tip body if an interim sealing layer is used without any reinforcement.

Capping Systems

Settlement cracks must be expected in the surface sealing around the rim of waste pits. In refuse dumps settlement and horizontal deformations jeopardize the surface sealing because the waste reduces in volume over a period of time.

The geosynthetic reinforcement has to meet the following requirements:

- good interaction with the soil
- high tensile strength at low elongation
- endurance at sustained loads (low creep sensitivity)

For the above mentioned applications, the high strength **Stabilenka®** has proved suitable. An additional high water permeability of the reinforcement is provided by reinforcement composite **Comtrac®**.

Steep slopes

On steep slopes, there is frequently inadequate sliding stability of the lining system. Low interface shear strength between the flexible membrane line (FML) and the protective layer is the reason. By stabilizing the drainage layer with **Fortrac®**-geogrids this problem can be solved. **Fortrac®** absorbs tensile stresses even at low elongation, avoiding excessive deformations.

Fortrac®, **Stabilenka©** and **Comtrac®** offer excellent mechanical properties, especially superior creep behaviour, being manufactured from high modulus, high tenacity polyester yarn (PET).

Detailed information on **Stabilenka®, Fortrac®** and **Comtrac®** for reinforcement and design proposals can be obtained from HUESKER Synthetic.

Research and development - no accident

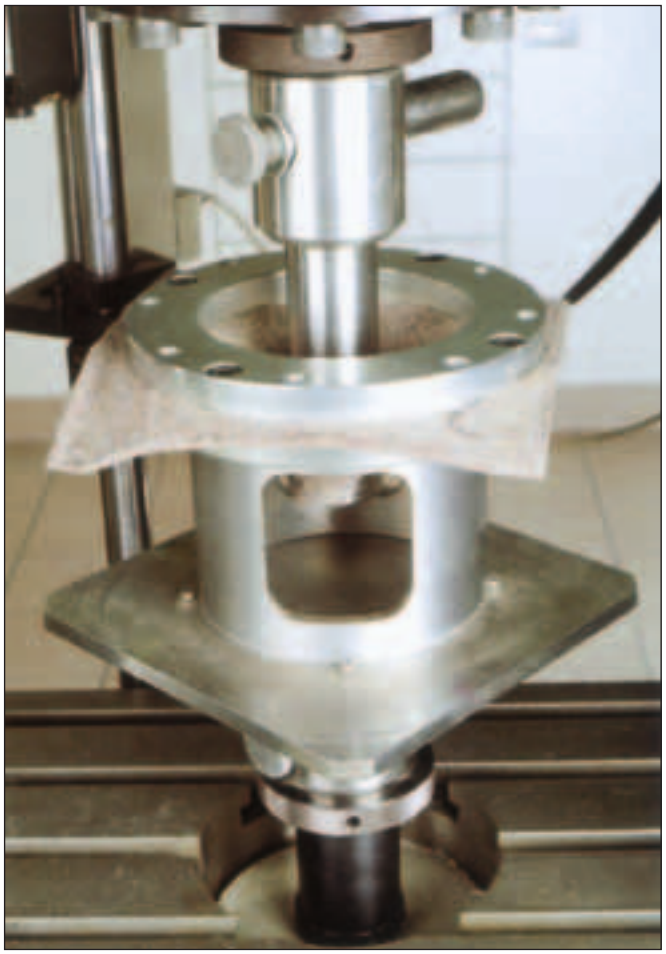
Since the early sixties, HUESKER Synthetic has been designing and manufacturing geosynthetics for a variety of applications in civil engineering. Our extensive experience has played a major part in helping us develop geosynthetics for the construction of landfills.

In open discussions with engineers and contractors, we formulate our research and development plans for new geosynthetics. According to engineering demands and application, whether it be separating, protecting, draining, filtering, reinforcing or sealing, our research and development department designs nonwovens, wovens, geogrids or composites from suitable polymers, without any technical restrictions. This work is carried out in close collaboration with leading institutes, civil engineering consultants and officially approved materials testing laboratories. This cooperation gives HUESKER Synthetic the back-up to develop and manufacture optimised geosynthetics for the construction of landfills which comply reliably, safely and durably with the high standard demanded.

Quality control from raw materials to end products

HUESKER-Products are subjected to stringend quality controls to ensure a consistent high standard of quality. The continuous chain of quality controls starts with the raw material. Fibres and yarns are manufactured from the polymer granulate, the properties of which are specified under strict quality control. These materials are then transformed into the end product on modern versatile production facilities. Quality control of the finished geosynthetic is guaranteed by internal procedures as well as external control by an officially approved materials testing laboratory to DIN 18 200. The supplier's identity can be checked on site by the label and printed markings on the geosynthetic rolls.

The quality assurance system of HUESKER Synthetic GmbH, Gescher is DIN ISO 9001



HUESKER Synthetic GmbH is certified by:

HUESKER offers a wide range of technically demanding solutions relying on our many years' experience. Our solutions are economical, reliable and up-to-date and used in:

Earthworks and foundation engineering, landfill construction, hydraulic engineering, road construction

Technical assistance, planning, support - worldwide

Reliable and advanced techniques characterise our products in many applications:

Fortrac® - a flexible, high modulus and low-creep geogrid for soil reinforcement

HaTelit® – a flexible, high-modulus and temperature resistant grid for asphalt reinforcement

Stabilenka® – a high-modulus polyester woven for reinforcement and separation of soils

Robutec® – a very high-modulus and alkali-resistant woven for reinforcement and separation of soils

Fornit® – a biaxial geogrid for subbase reinforcement

Comtrac® – a geocomposite for reinforcement, separation and filtration of soils

Duogrid® – a geocomposite made of biaxial high-modulus flexible geogrid and a nonwoven

NaBento® – geosynthetic clay liner for sealing

Incomat® – a concrete- or sand-mat for sealing and erosion control

Ringtrac® – geotextile tube for reinforcement and soil containment

HaTe® – wovens and nonwovens for separation, filtration, drainage and protection

Geosynthetics made by HUESKER - reliability by experience!

HUESKER

HUESKER Synthetic GmbH
Fabrikstraße 13-15 · D-48712 Gescher
P.O. Box 1262 · D-48705 Gescher
GERMANY
Phone: +49 (0) 25 42 / 7 01-0
Fax: +49 (0) 25 42 / 7 01-499
E-Mail: info@huesker.de
Internet: www.huesker.com