Fortrac®

Flexible low-extension geogrid for geotechnically demanding solutions

HUESKER

Engineering with Geosynthetics

Fortrac® – geogrids for future-oriented construction with technical and economic benefits

Steepened slopes

Bridge abutments

Segmental Retaining walls

Piled embankments

Sinkhole protection

Basal reinforcement

Brownfield sites

Landfills

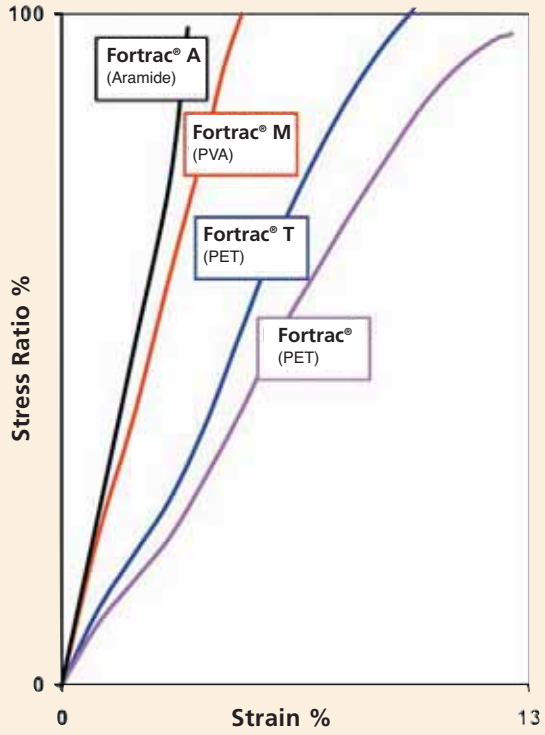
Examples can be found on our website: www.huesker.com

Fortrac® – geogrids incorporating high-tech features

Fortrac® is a flexible, extremely high-strength geogrid that has been used for reinforcing soils for over 20 years.

Fortrac®-geogrids are manufactured from high-modulus, low-creep synthetic raw materials and coated with a layer of protective polymer. The special techniques used to manufacture **Fortrac®**-geogrid provide it with high stability at the rib junctions. High-modulus polyester (PET) has been our standard in terms of synthetic raw material for geosynthetics for more than 20 years. Particularly demanding requirements have led to the development of **Fortrac® M** and **Fortrac® A**.
Whilst **Fortrac® A** provides very high tensile stiffness, **Fortrac® M** offers improved tensile stiffness in combination with high chemical resistance, particularly in an alkaline environment. **Fortrac®** can be supplied in various aperture sizes and in standard strengths of between 20 and 400 kN/m.

Strengths over 1600 kN/m can be supplied for special applications.
The product width of five metres reduces overlaps to a minimum. Special sizes can also be supplied at short notice. **Fortrac®** benefits clients and contractors through our continuous improvement of its properties and the simplicity and speed of handling and installation.

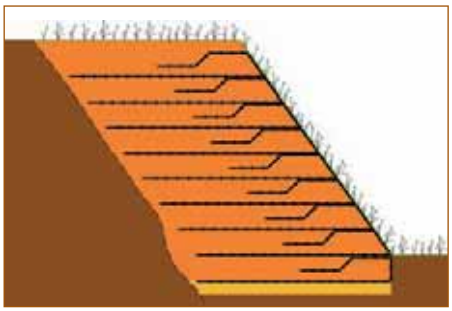


Typical tensile stress/strain behaviour of four **Fortrac®** products

The advantages are:

- availability in a wide range of strengths
- optimum tensile stiffness
- very low creep
- high resistance to micro-organisms and chemicals in the soil, UV light and mechanical damage
- proven excellent geogrid/soil interaction values
- flexibility in the choice of raw material to ensure a perfect match to the project requirements
- highly pliable for ease of handling and problem-free installation
- low cost
- expert support during design and construction provided by our experienced team of engineers

Fortrac® – steepened embankments



Steepened embankments (normally with slope angles of up to 70°) are those in which the slope angle is greater than the angle of internal friction of the soil. This means the slope needs to be reinforced. **Fortrac®**-reinforced embankments provide a cost-effective alternative to conventional solutions in these circumstances. Examples include noise bunds, planted embankments, dykes or embankments supporting trafficked areas (such as roads or car parks) or railway tracks.

The advantages of this type of reinforced soil construction are:

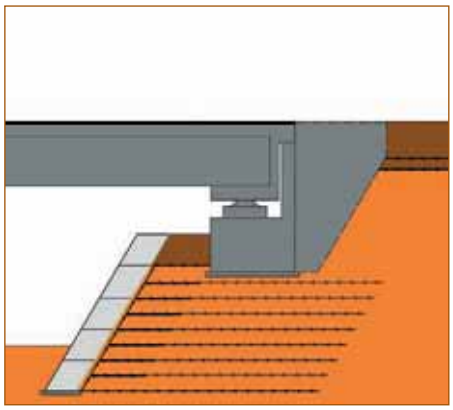
- slopes can be designed to blend into surrounding landscape
- local insitu soils can be used
- reduced amount of land required
- low sensitivity to differential settlement of foundation soils
- lower requirement for conventional construction materials (e.g. concrete)
- simple installation
- cost-effective

Slopes can be planted with vegetation to protect them against erosion. Normally a lighter weight geosynthetic or an anti-erosion mat is installed in the 'wrapped back' **Fortrac®**-geogrid to prevent the fine soil particles from being washed out. This also ensures vegetation and root structures have sufficient time to develop. Gabions or stonework may also be used as the outer skin.

Complete descriptions of projects can be found on our website: www.huesker.com

The provision of effective drainage must be addressed during design and construction. Without it the reinforced soil system may lose its internal or external stability. HUESKER's Engineering Department would be pleased to advise you on any design questions.

Earth-retaining structures with Fortrac®



Earth-retaining support structures (normally with a slope angle of 70° to 90°) constructed with **Fortrac®**-geogrid reinforced soil are an economic alternative to conventional forms of construction, such as gravity walls or bridge abutments.

The advantages are:

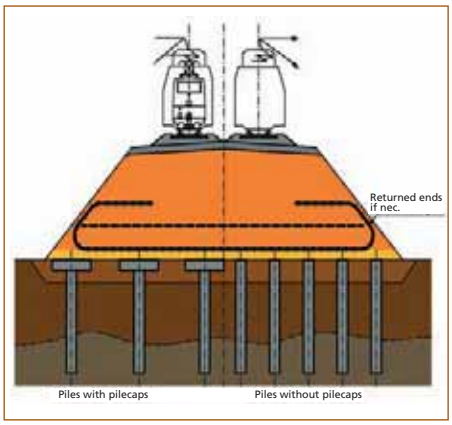
- can be designed to blend into surrounding landscape
- local insitu soils can be used
- reduced amount of land required
- low sensitivity to differential settlement of foundation soils
- lower requirement for conventional construction materials (e.g. concrete)
- simple installation
- economic advantages

The outer skin can consist of gabions, prefabricated panels, concrete blocks or sprayed concrete. In certain circumstances a planted outer skin may be used. HUESKER's Engineering Department would be pleased to advise you on any design questions.

Fortrac® geogrids are ideal for reinforcing steepened embankments or earth-retaining support structures:

- high-modulus, low-creep yarn keeps deformations small
- excellent long-term behaviour ensures the structure retains its stability
- good composite action between soil and grid provides an economical design
- a wide choice of polymers allows optimised project-specific reinforcement
- construction with flexible **Fortrac®**-geogrid is simple and efficient

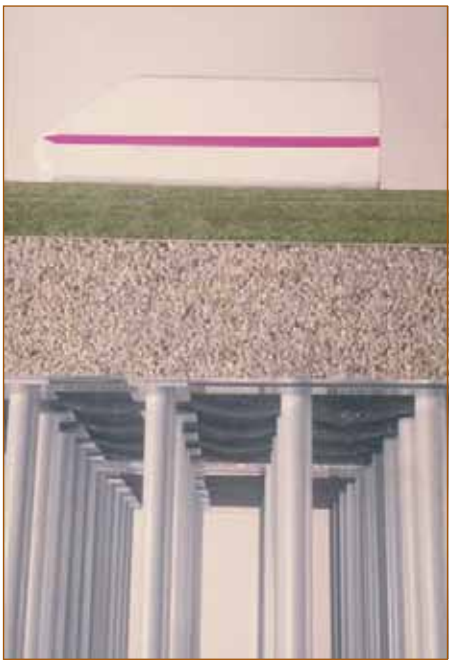
Piled foundations with Fortrac®



To reduce settlement occurring as a result of poor bearing capacity soils, embankments can be founded on a grid of piles or ground improvement columns. The piles transfer loads from the embankment and traffic down to lower, more competent soil strata. A single or double layer of geogrid is laid over the piles or similar supports to distribute the loads into them and resist any spreading forces at the base of the embankment.

This solution is preferable for the following reasons:

- the embankment can be used immediately, without having to wait for completion of settlement and consolidation
- minimisation or prevention of deformation of the embankment after completion or during operation
- avoidance or minimisation of excavation and transport of soils
- elimination of effects on adjacent components, e.g. pipes, foundations, etc.



The ‘soft layers’ are not or only minimally stressed as the **Fortrac®**-geogrid transmits the loads to the supporting members.

The installed system is therefore extremely maintenance-free. To prevent or minimise deformations of the earthworks structure after completion and bringing into use **Fortrac®**-geogrids are made solely from low-creep raw materials. Polymers with a high tendency to creep, such as PP or PE, should never be considered for use in these circumstances.

Technical details can be found on our website: www.huesker.com

Piled embankment, Project: N210, NL

Sinkhole protection with Fortrac®

In transportation projects and in many other types of construction works there are often problems caused by unanticipated subterranean voids. These hidden voids may only develop many years after completion of construction and lead to loss of life or property damage.

There is a greater risk of this happening in limestone areas, from erosion caused by water leaking from pipes, in former mining areas or on sites where contaminated land or landfills have been reclaimed or covered.

The at-risk area can be reinforced with a high-strength **Fortrac®**-geogrid to prevent the effects of a collapse in the underlying strata migrating through to the ground surface. The

geogrid maintains the stability of the road or rail track until additional safety measures can be implemented, thus avoiding consequential death, injury or damage to property or the environment.
If necessary, electronic monitoring and warning devices can also be incorporated into these systems.

To minimise deformations at the ground surface even after the formation of a sinkhole, **Fortrac®**-geogrid is made solely from low-creep raw materials.

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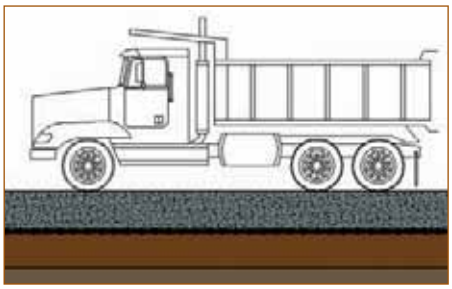
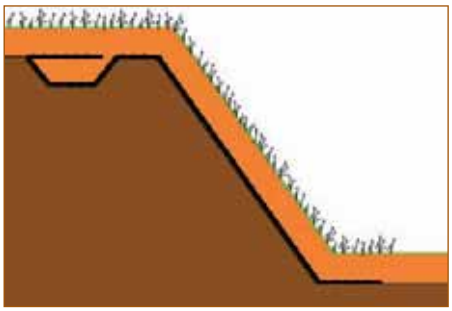
Ensuring safety of a railway junction in the former mining area of Gröbers

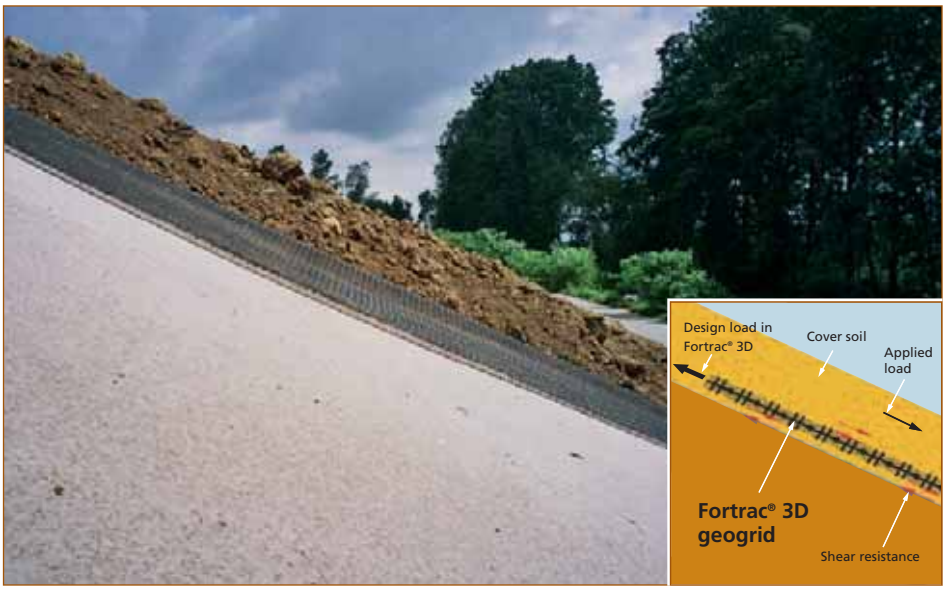
Basal reinforcement with Fortrac®



Roads, temporary access tracks or parking facilities often have to be constructed over ground that is unreliable or of inadequate bearing capacity. **Fortrac®**-geogrid is used here to increase the bearing capacity and the safety factor against ground failure on the site. This economic solution avoids the need to replace insitu soils and reduces the required thickness of the applied layers. **Fortrac®**-geogrid's low tendency to creep means that it does not noticeably extend even after many cycles of dynamic loading, which permanently stops the development of rutting and other deformations.

Veneer reinforcement with Fortrac®



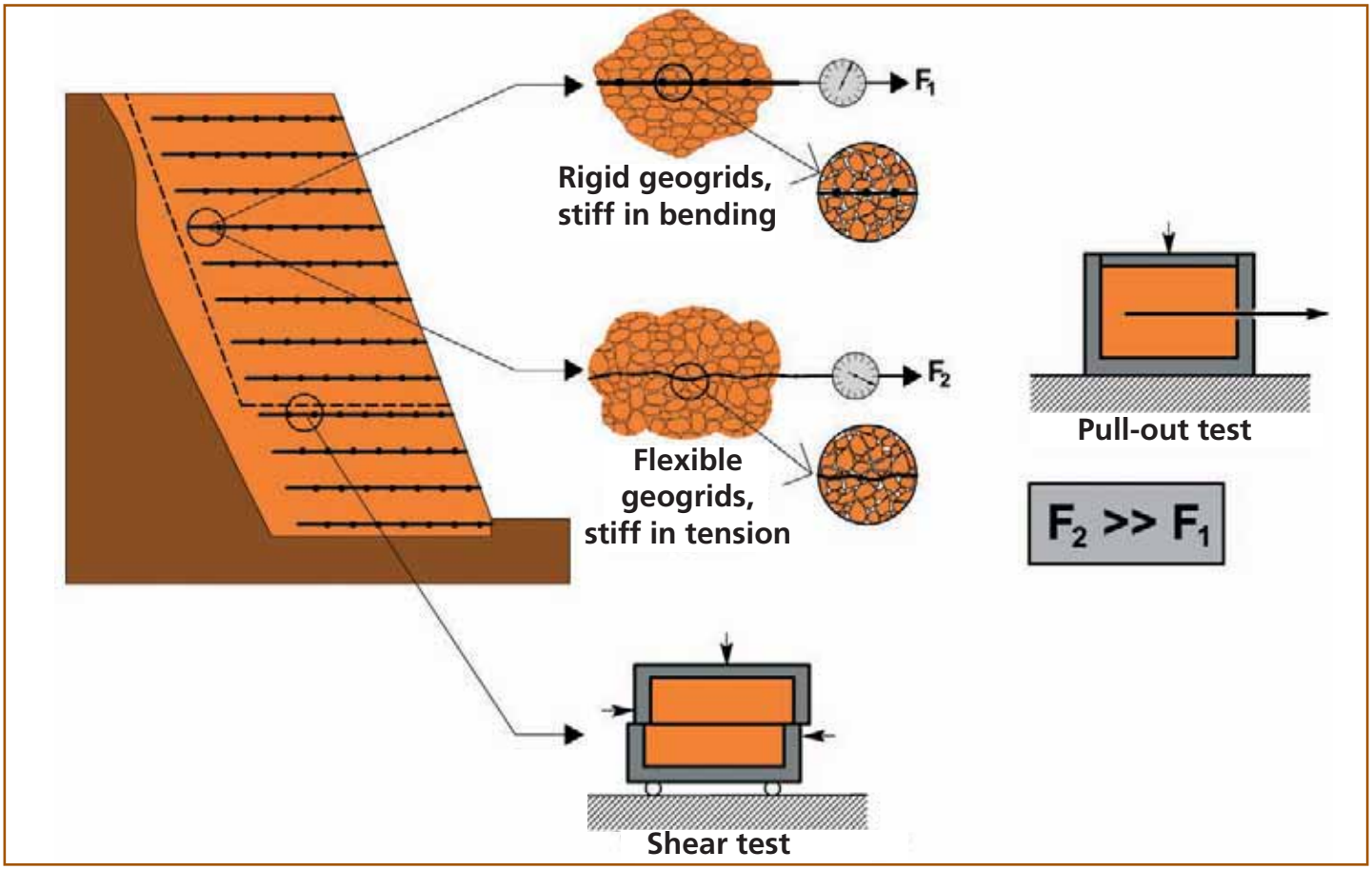


Slopes are often made as steep as possible for economic reasons to gain additional useful land or landfill volume. **Fortrac®**-geogrids can be installed as reinforcement to achieve stability, even in the situation where slopes are made steeper than the soil parameters or friction at the critical slip surface would normally allow. **Fortrac®**-geogrids carry the shear forces in the direction of slope and ensure its permanent stability. **Fortrac® 3D** geogrid can be used if the covering soil requires additional protection against erosion. **Fortrac® 3D** is a flexible, three-dimensional reinforcement grid, the structure of which allows it to considerably increase erosion resistance.

Fortrac® interaction with the soil

The use of **Fortrac®** is advantageous because its interaction with the surrounding soils is optimised through the superior pull-out and shear resistance of the geogrid.

The interaction of the soil with the reinforcement is an important factor in the behaviour of a reinforced soil body.
The only recognised and standardised test methods for assessing the interaction of the soil with the geogrid are pull-out and shear tests.



Soil/geogrid properties

These tests measure the friction coefficient between soil and geogrid. This parameter is important and can be used directly in stability calculations. The pull-out and shear resistances values reflect the actual behaviour of the geogrid in the soil.

They depend on the following factors:

- loading
- frictional resistance of the geogrid strands
- geometry of the geogrid
- parameters of the surrounding soil (e.g. internal angle of friction)
- grading or particle size distribution of the soil
- soil/geogrid interaction
- flexibility of the geogrid

The proven advantage of **Fortrac®** is its combination of flexibility, friction and interlock. Therefore **Fortrac®** has excellent interaction properties. Calculations show **Fortrac®** to be extremely economic with respect to its pull-out and shear resistance performance (EN ISO 12957 and EN ISO 12957-2).

Fortrac® provides excellent and verifiable interaction with all types of contact soils!

Durability and long-term behaviour

The durability of geogrids is another important factor which depends on the following:

- selection of raw material
- production method
- application requirements

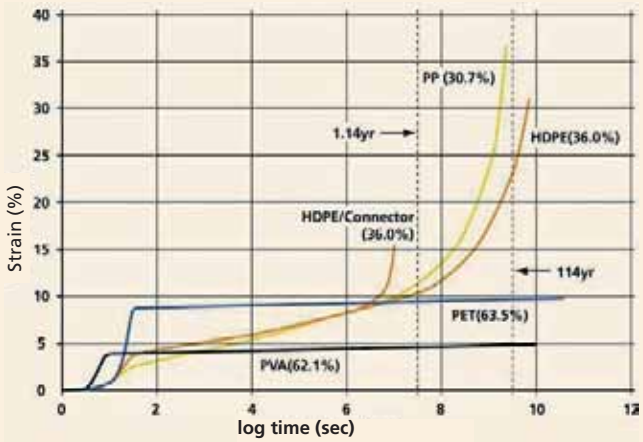
Fortrac® is manufactured exclusively from high quality raw materials. In order to be able to satisfy every project-specific requirement, HUESKER has developed an extensive range of different **Fortrac®** products, each with its own well proven advantages.

- low creep
- high resistance to UV light
- high resistance to microorganisms
- high resistance to chemicals
- high resistance to mechanical damage

Type	Application	Raw material	Properties
Fortrac® and Fortrac® T	– standard – low strain	PET (Polyester)	– excellent tensile stiffness – low creep – little installation damage – chemical resistance pH 4 - 9.5
Fortrac® M	– standard – very low strain – extreme environmental effects	PVA (Polyvinyl alcohol)	– excellent tensile stiffness – low creep – little installation damage – chemical resistance pH 2 - 13
Fortrac® A	– extremely low strain – extremely high strength	AR (Aramid)	– excellent tensile stiffness – low creep – little installation damage – chemical resistance pH 4 - 9.5

Creep behaviour

The application determines the required technical parameters of the geogrid – including the choice of polymer. Selecting the right polymer has a crucial influence on the creep behaviour of the final product. The graph shows the strain/time relationship at three different levels of loading (shown in brackets). The polyolefin products (HDPE and PP) show a rapid increase in extension with respect to time with a much lower creep rupture resistance than PET and PVA.



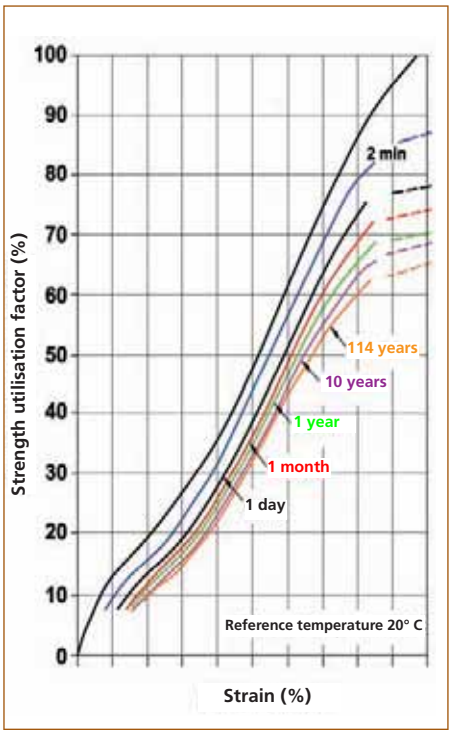
Creep behaviour of various polymers. Figure in brackets: Strength utilisation factor

All **Fortrac®**-geogrids are manufactured from high quality raw materials with low creep properties.
Fortrac® is tested and certified by independent materials laboratories.

Fortrac® = LOW CREEP

The load- and time-dependent deformation can be determined from isochronous curves. In this way it is possible to reliably calculate the possible post-construction deformation of an earthworks structure.

All products in the **Fortrac®** range are tested and their properties comply with the applicable guidelines in this respect.



Further technical details can be found on our website: www.huesker.com

Advantages of flexible **Fortrac®**-geogrids:

- the performance of **Fortrac®** is superior to that of polyolefin products (PE and PP) because of its low-creep properties
- the flexibility of **Fortrac®** makes it simpler and quicker to install than rigid geogrids
- the standard product width of 5.0 m provides greater efficiency of use in installation
- for the same short-term strength **Fortrac®** provides a higher allowable design strength
- high flexibility of production with respect to tensile stiffness, tensile strength, raw material choice and geometry
- more than 25 years of proven experience – worldwide -
- **Fortrac®** is tested and certified and subject to monitoring by an independent inspection body

Quality assurance

The assurance of product quality is important for successful product implementation.
To fulfil the highest quality requirements, HUESKER is subject to numerous external and independent certifications and audits.
HUESKER is certified in accordance with DIN EN ISO 9001:2000
The company's in-house laboratory is also accredited in accordance with DIN EN ISO/IEC 17025 by Deutsches Akkreditierungssystem Prüfwesen GmbH. The specified product properties are based on key parameters that can be tested and verified in accordance with CE and ISO standards.

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

SoilTain® – systems for hydraulic engineering and dewatering

Geosynthetics made by HUESKER - reliability by experience!

HUESKER

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