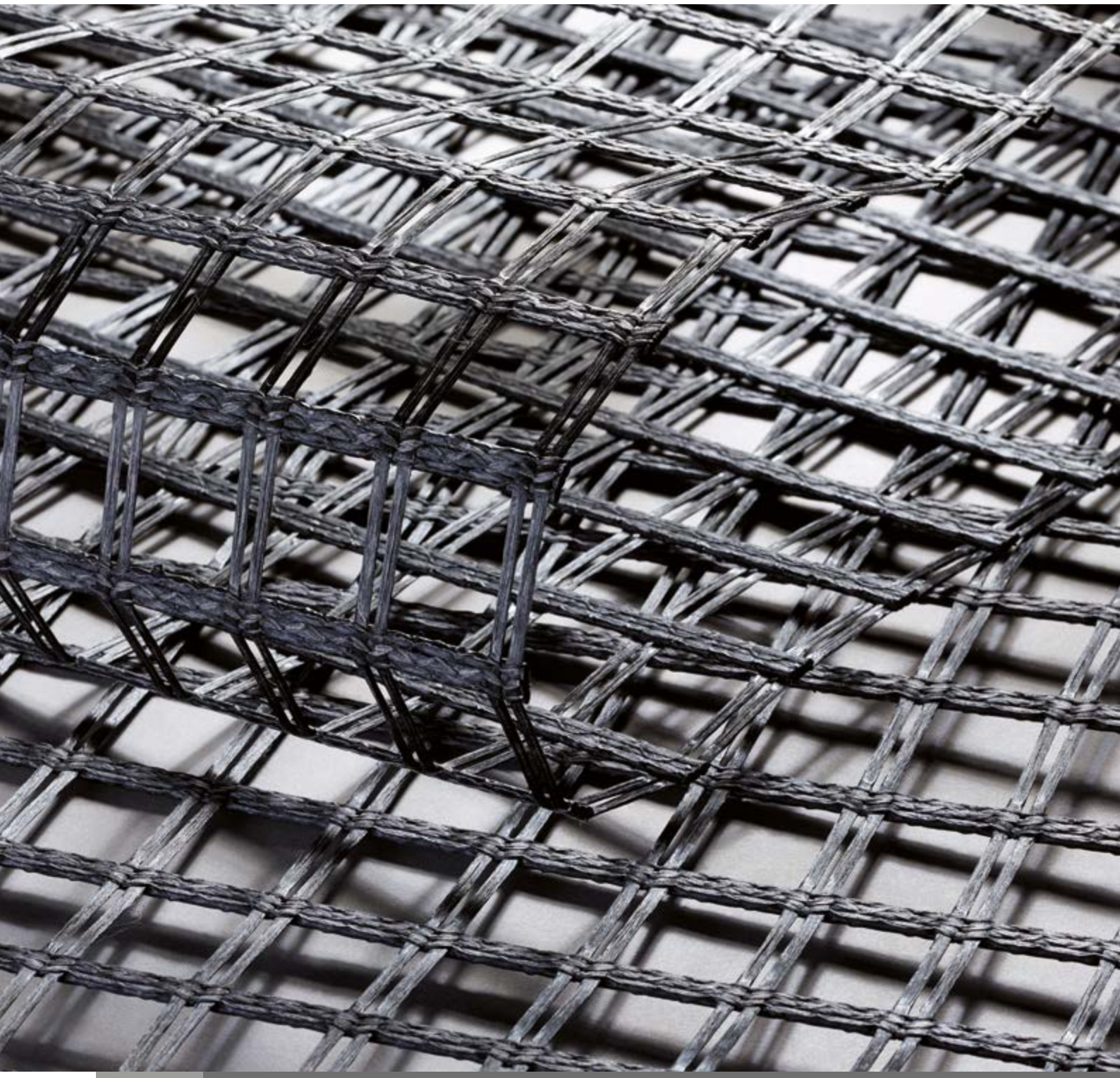


Fortrac®

Immensely Versatile Solutions for Reinforced Soil

HUESKER

Ideen. Ingenieure. Innovationen.

BENEFITS

- Up to 3,000 kN/m strengths and 100 mm mesh sizes
- High stiffness and low creep
- Less excavation and lower construction costs
- Reduced footprint through extra-steep construction
- Uniform product strength, even at intersections

Fortrac Geogrids

Immensely versatile solutions for reinforced soil.

Boasting a 30-year-plus track record, Fortrac offers an all-round soil reinforcement solution. The Fortrac geogrids are made from high-modulus, low-creep synthetic materials enclosed in a protective polymer coating.

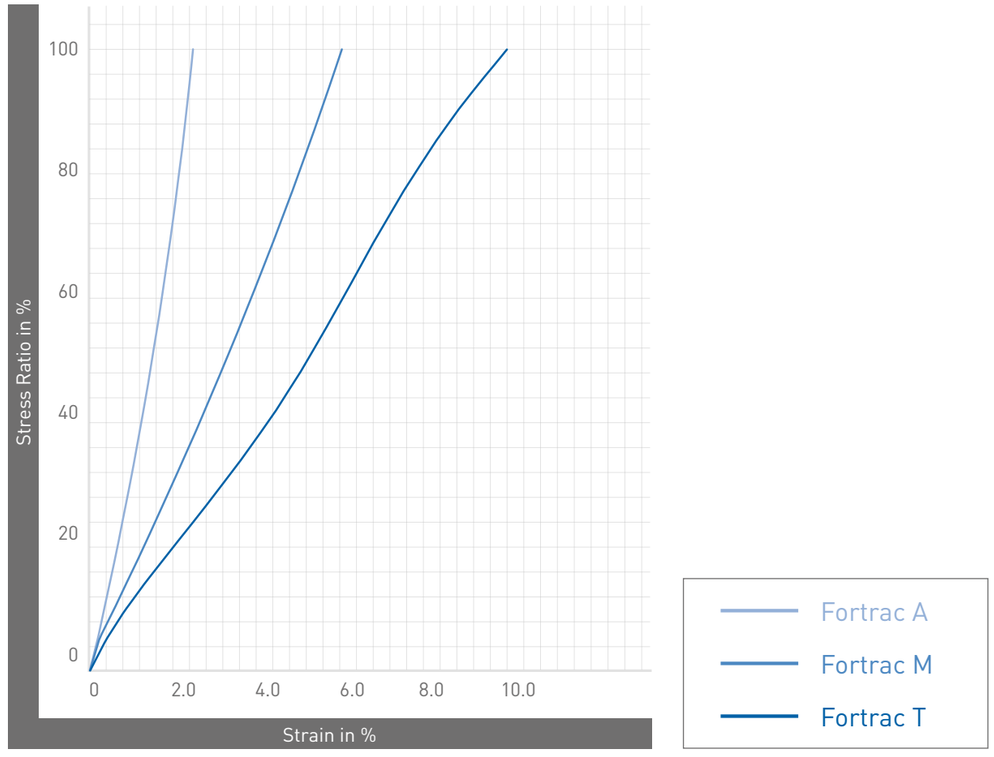
Three different raw materials cater for a tremendously broad range of applications while meeting the most stringent project requirements. In some cases, special requirements have prompted the use of advanced polymers, e.g. polyvinyl alcohol (PVA) and aramid. While aramid guarantees exceptionally high axial stiffness, PVA offers high tensile stiffness in conjunction with enhanced resistance. PVA is particularly useful for applications involving chemical extremes in alkaline or acidic environments. High-modulus polyester (PET) has been the standard raw material for our geosynthetics for over 30 years.

Fortrac is available in various mesh widths and standard tensile strengths of up to 800 kN/m. Strengths of up to 3,000 kN/m can be supplied for special applications.

Fortrac	
Material	PET, PVA, Aramid
Tensile strength(s)	Up to 3,000 kN/m
Coating	Polymer
Function	Reinforcement

Stress/strain curve

to EN ISO 10319



Key geogrid properties

Striking the right balance.
In selecting geogrids for construction projects, it is important to focus on those product properties that are key to optimising reinforcing performance as a means of guaranteeing structural safety. The three key properties are presented below:

Tensile stiffness

- This is important for the accommodation of loads with a minimum of deformation.
- Reinforcement with inadequate tensile stiffness allows unacceptably high deformation.
- Reinforcement with excessive tensile stiffness prevents soil from mobilising its maximum shear strength.

Tensile strength

- The reinforcement has to be able to accommodate tensile forces in order to compensate for inadequate structural strength.
- To guarantee an appropriate standard of safety, different structures require different levels of tensile strength.

Interaction flexibility

By interaction flexibility, we mean the combined ability of a reinforcement product to:
- accommodate forces from the soil by means of a strong bond – achieved through optimisation of the bonding properties (micro-, meso- and macro-interlock).
- adapt flexibly to soil particles in order to prevent void formation.

Adequate tensile stiffness	+	**Good interaction flexibility**	+	Adequate tensile strength	=	**Optimum reinforcement / safe structure**
		Good interaction flexibility	+	Adequate tensile strength	=	Reinforcement strain / slight structural deformation possible
Adequate tensile stiffness	+			Adequate tensile strength	=	Inadequate activation of reinforcement / structural failure possible
Adequate tensile stiffness	+	**Good interaction flexibility**			=	Reinforcement failure / structural failure

=

Micro-interlock + **Meso-interlock** + **Macro-interlock** + **Adaptability**

Fortrac in compacted soil

Fortrac woven geogrids offer outstanding interaction flexibility

The surface roughness of the coated multifilament yarns used in the manufacturing process ensures excellent interlock with soil particles at microscopic level. A similarly strong meso- and macro-scale interlock is achieved by the elastic coating and mesh aperture size respectively. Fortrac's high flexibility explains its ability to adapt to uneven surfaces. Here, the prestrain undergone by the geogrid in the compacted ground results in the mobilisation of tensile forces, even during installation, that create a "spatial" support system for the soil. Flexibility thus offers major benefits in terms of mobilising tensile forces in reinforcement.

Meso-interlock

Interlock between soil particles and geogrid ribs due to surface texture.

Macro-interlock

Penetration of stones and gravel through mesh openings, i.e. full interlock between rock components and grid.

Adaptability

Ability of flexible geogrid to adapt to unevenness in soil during compaction.

Micro-interlock

Synonym for friction/adhesion: microscopic interlock of soil particles with grid surface.

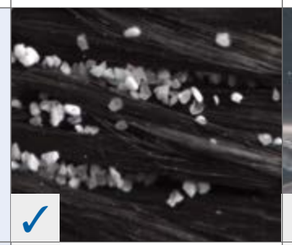
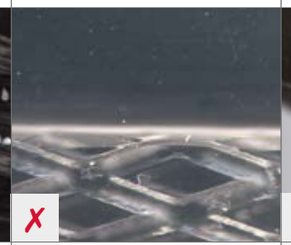
20-fold magnification: rough surface texture of Fortrac, pictured here with 0.1-0.3 mm sand particles which achieve interlock at microscopic level and increase friction.

Relevant properties of geogrids

The reinforcement (welded PET) generally performs worse than the PET woven geogrid. This is due to the low interaction behaviour between geogrid and soil.

(Prestressed reinforced soil – Concept, investigations and recommendations. Dissertation C. Lackner, Graz 2012)

Flexible geogrids *versus* **rigid geogrids**

Effects	Woven grid		Welded grid		Punched and drawn grid	
Micro-interlock*		✓		✗		✗
Meso-interlock	✓	Full surface rough and elastic	✗	Hard surface reduces interlock	✗	Hard surface prevents interlock
Macro-interlock	✓	Mesh size is adequate	✓	Mesh size is adequate	✓	Mesh size is adequate
Adaptability	✓	Extremely flexible and pliable	✗	Very rigid, especially at high strengths	✗	Very rigid

* Microscope images at same magnification of standard proprietary geogrid products

In addition, the soil reinforcement interaction improves if the geogrid reinforcement is able to fit in and arrange itself properly around the soil particles to avert voids in the soil structure. In other words, the installation of very stiff geogrids may lead to negative interaction effects.

(Prestressed reinforced soil – Concept, investigations and recommendations, Dissertation C. Lackner, Graz 2012)

Benefits of Fortrac

Excellent adaptability

- Creates a "spatial" support system and accommodates inhomogeneities
- Reduces the number of voids at contact points with geogrid
- Straightforward placement with minimum installation damage

Formation of a **flexible integral system** with soil

No prestressing of geogrid necessary for base reinforcement applications

Extra UV protection provided by **polymer coating**

High interaction flexibility, even in conjunction with very high tensile strengths

Fortrac - The right product for every application

Geosynthetic Reinforced Soil (GRS)

- Lower footprint through extra-steep construction
- Straightforward installation with no geogrid “memory effect”
- Design optimisation and project-specific adaptation thanks to wide range of product raw materials and strengths

Bridging of Sinkholes

- Bridging of large sinkholes to control settlement at ground level
- Straightforward installation with no geogrid “memory effect” thanks to flexible material
- Savings in materials due to excellent bond

Landfill Construction

- High tensile strengths allow steeper landfill slopes and greater volume capacities
- High bond coefficient, even in conjunction with very high tensile strengths
- BAM (German Federal Institute for Materials Research and Testing) approval for up to 1,300 kN/m

Working Platforms

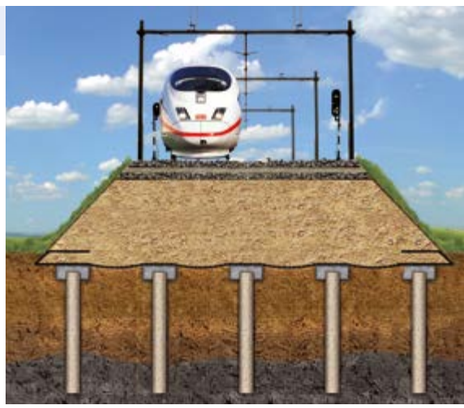
- Cost savings due to reduction or avoidance of soil replacement
- Outstanding suitability for extreme loads
- Single-layer reinforcement for high loads avoiding the need for multi-layer solutions

Base Reinforcement

- Reduction of construction costs and time through minimisation of base material requirement
- EBA-certified (German Federal Railway Authority) for use in railway engineering
- Possible application in aggressive environments, with wide-ranging options provided by different raw materials

Embankments on Piles

- Exceptionally high tensile strengths allow optimisation of pile spacing and pile cap size
- Efficient installation using single-layer placement in either direction
- High safety standards backed up by certification



Fortrac in service

Membrane effect in piled embankment application
(Railway Bidor-Rawang, Malaysia)

Bridging of sinkhole
(Bochumer Westkreuz motorway interchange (A 52), Germany)

Geotextile reinforcement installed on piles
(N 210; Netherlands)

Tied-back gabion wall (A3 motorway near Haseltal, Germany)

HUESKER services

HUESKER services begin with providing the customer with initial advice and end with supporting the realisation of the project on site. What we provide are safe, customised, ecologically sound and economically viable project solutions.

Services provided by our engineers

- **Geotechnical design**
  Our engineers assist design practices by performing verifiable design calculations in accordance with international codes of practice.
- **Technical consulting**
  We will recommend the appropriate product types for your specific requirements.
- **Project-specific placement plans**
  We will prepare installation and placing recommendations plus installation drafts.

Documents

- **Certificates**
  Our products have BAM, BBA , EBA, SVG and IVG certification
- **Installation guidelines**
  Technical guidelines will help you to ensure the best-practice installation of your product on site.
- **Tender documents**
  We would be happy to provide you with proposals for your specification texts.

Product services

- **Custom-designed product solutions**
  We will partner you in developing custom-fabricated products to meet your particular requirements.
- **Alternative solutions**
  We will propose alternative design solutions as well as recommendations for adjustments and optimisations.

On-the-spot

- **On-site instruction**
  Where required, our application technicians can offer installation assistance related to the specifics of product installation.
- **Installation aids**
  We can offer you practical installation aids to facilitate the application of our products.
- **Training**

Fortrac® is a registered trademark of HUESKER Synthetic GmbH.

HUESKER Synthetic is certified to ISO 9001 and ISO 50001.

HUESKER Australia Pty Ltd

23 Dacmar Road
Coolum Beach
QLD 4573, Australia
Phone: 07 30888000
Mail: office@HUESKER.com.au
Web: www.HUESKER.com.au

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