

Geosynthetic Ingenuity in Mining

Highly Engineered Geosynthetic Solutions

We shape

the World

The HUESKER Group is a leading manufacturer of geosynthetics and technical textiles. The corporate head office of the HUESKER Group is located in Gescher (Westphalia), Germany. As a globally active company, the Group has ten subsidiaries and cooperates closely with trading and distribution partners in more than 60 countries. HUESKER has been shaping international markets as a pioneer of textile weaving for over 150 years.

The HUESKER Group substitutes conventional construction with sustainable and intelligent solutions from the area of modern and high-performance technical textiles. With its products and services HUESKER provides solutions in the areas of Earthworks and Foundations, Roads and Pavements, Environmental Engineering, Hydraulic Engineering and Mining, as well as applications in Industrial and Agriculture. First class engineering technical services, a high competence in manufacturing, coating as well as tailoring of technical textiles and innovative spirit are the key to HUESKER's success.

If a project is challenging HUESKER will find a solution! HUESKER



Our Capacity

Your Capability



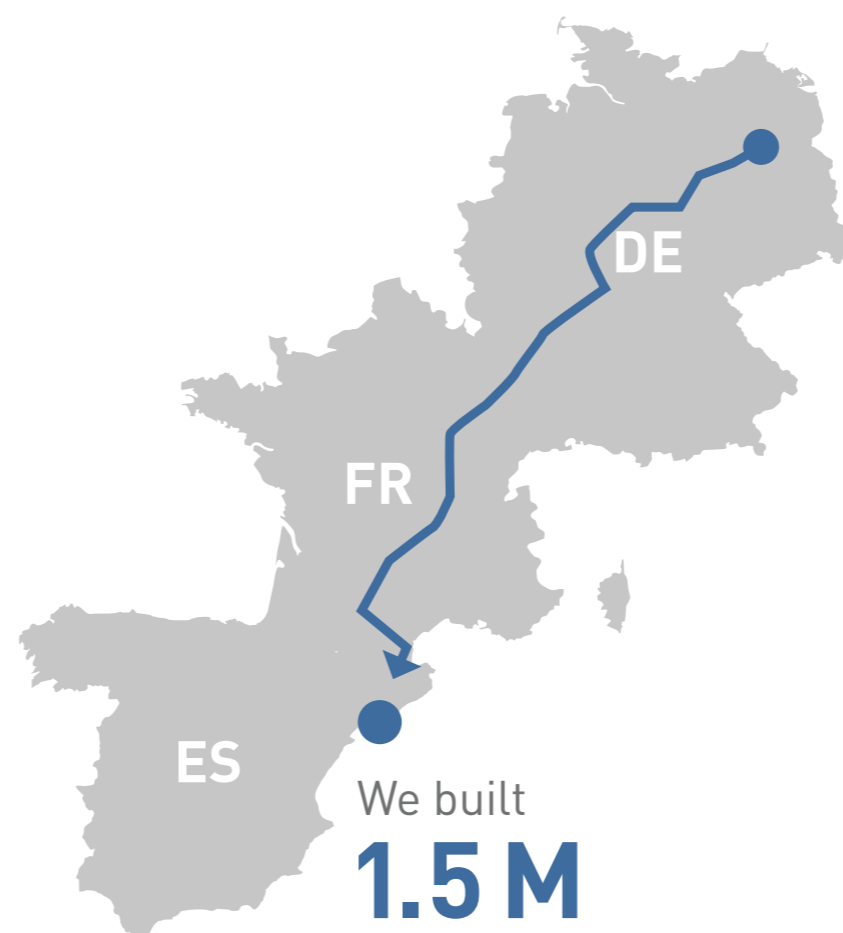
A one metre wide strip of our geogrid can carry up to **300 tons** which is equal to one **Airbus A380**



We provide customers across the globe with over **40 M m²** high strength geosynthetics per year

This is equal to a one metre wide belt around the equator every year.

We have reinforced or rehabilitated more than **5,000 km of motorways** over the past few years.



We built **1.5 M metres** of Geosynthetic Encased Columns in the past few years. This equals the distance from **Berlin to Barcelona.**

We supply products with a durability of more than **100 years.**

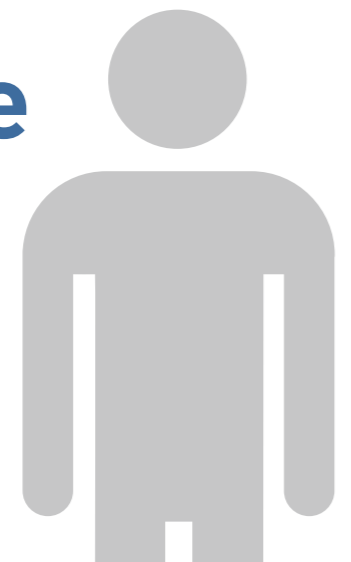
We have even constructed reinforced soil walls with obtuse angles of **110 degrees.**



We environmentally sealed an area of more than **1,500** soccer fields or **11 M m²** in recent years.

Every 7th employee

at HUESKER is an **Engineer**



We provide design calculations for more than **500 projects per year**

MINING

Challenges

Safety

Reduction of risk

Sustainability

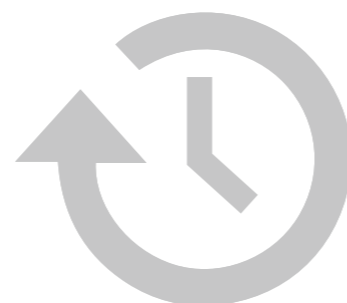
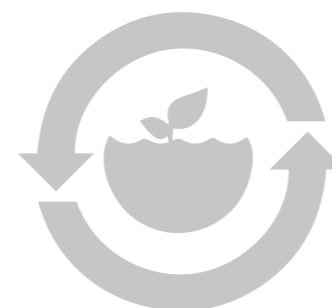
Environmental responsibility

Time

Product to market

Economics

Decreasing all-in costs



HUESKER

Performance

- **Elimination** of failure through the reduction of risk
- **Dedicated** and responsible geosynthetic design
- **Reduced** vehicular traffic

- Better stakeholder **relations**
- **Decreased** carbon footprint
- Beneficial **re-use** of mine residuals

- **Fast and practical** installation
- **Reduced** construction delays
- **Reduction** of implementation stages

- Increased heap leach **recovery**
- **Reduction** of construction time
- **Optimisation** of footprint utilisation

Solutions

from Pit to Port

Embankment construction

Solutions on page 12

Underground support

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Interface stabilisation

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Tailings dams

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Barrier protection

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Platform stabilisation

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Liquid transportation

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Road and rail

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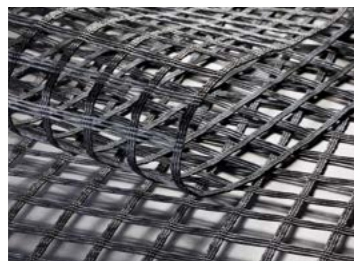
Ports

Solutions on page 23





Steep Embankment Construction



Fortrac



Stabilenka

Challenge

Global economic drivers affect mining decision making. Civil engineering structures, including critical earthen walls, slopes, dams and embankments require high volume and high output construction. Double handling of any materials negatively impacts the profitability of the mine. Constructing civil engineering structures relying only on the natural characteristics of the available onsite materials can lead to problems with stability and possible failure.

Solution

HUESKER offers engineered soil reinforcement solutions, which allow extra-steep and safe construction. Higher and steeper slopes, walls and embankments enables reduced material handling and importation requirements. Designing, for example, steeper sloped waste rock dumps allows for economic utilization of the dump rock footprint area and could additionally lead to the simplification of rehabilitation considerations.

Your advantage:

- Reduced space requirements due to extra-steep embankment construction
- Reduced total carbon footprint due to less material and greater use of site won materials
- Wide range of available polymers enables geosynthetic reinforcement in aggressive pH environments
- Increased Interaction Flexibility between our geosynthetic and fill enables the potential use of locally available material
- Less excavation and reduced construction costs
- Increase in slope and embankment stability and safety
- Reduced construction time



Longwall Recovery, Highwall and Rib Support

Challenge

The safety of a mine's recovery system is paramount, whether dealing with longwall recovery rooms, high walls or ribs. The required support system must be able to fulfill the safety and stability requirements.

Solution

HUESKER Minegrid comprises high-strength geogrids manufactured from polyester (PET) or polyvinyl alcohol (PVA), that are woven under tension and provide the required attributes to meet the recovery challenges including high tensile stiffness, flexibility, resistance to corrosion and conductivity, high visibility, and where necessary conforming to Fire Retardant Anti-Static (FRAS) requirements. HUESKER Minegrid fulfills all of the requirements of a supporting element in underground mines.



Minegrid

Your advantage:

- High Strength at Low Strain means long-term support with minimal deformation, confining rock faces to reduce movement and reduced 'bagging'
- Corrosion resistance and non-conductivity ensure long service life in all areas of a mine or quarry
- FRAS rating meets all requirements of Mine Safety and Health Administration (MSHA)
- High strength to weight ratio enhances usability and reduces injuries
- High visibility coating
- Broad range of Minegrid products allows for customization and concentration of strength in crucial zones



Barrier Interface Stabilisation



Fortrac



Stabilenka

Challenge

Heap leach pads are considered the highest lined fills in the world. The stability of the ore lifts is critical in order to avoid potential downhill heap failure. Stacking more ore faster enables faster returns, however, high loads and harsh chemical environments provide limited pad liner interface stabilisation options.

Solution

The stabilisation of the pad liner/overliner interface with chemically resistant geosynthetic reinforcement materials provides opportunities to stack ore lifts higher while maintaining the stability and integrity of critical interfaces. HUESKER offers engineered geogrid or geotextile reinforcement solutions which are proven to have high chemical resistance and long term stability.

Your advantage:

- Increase liner interface stability
- Faster stacking of more ore leading to greater and quicker returns on investment
- Chemically resistant raw materials contribute to pad liner longevity
- Increases heap leach pad site safety



Veneer Reinforcement

Challenge

Challenging geographical mine locations often require valley fill heap leach pads which are constructed in rugged terrain. Significant earthworks operations are required to construct and prepare steep slopes including the required barrier layers. Barrier systems exposed to permanently high ore loads and/or potential seismic activity adversely impacts the barrier system performance and longevity.

Solution

Our geosynthetic engineering experience and capabilities enables the design of project specific solutions to enable the decoupling of loads from the heap leach pad barrier system. Geosynthetic reinforcement solutions which reduce or eliminate ore load transfer to the barrier system contributes to critical barrier system longevity and improved seismic interface stability.



Fortrac

Your advantage:

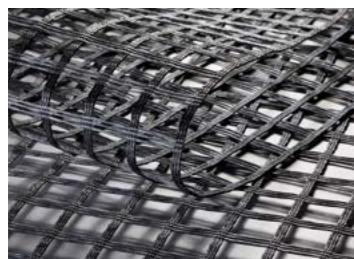
- Decoupling the barrier system from the ore loads
- Enabling steeper slope construction
- Increasing ore stacking volumes
- Contributing to interface stability of barrier systems



Tailings Dam Embankment Construction



Tektoseal Clay



Fortrac



SoilTain DW

Challenge

Due to the environmental requirements related to the disposal of tailings, tailings dams are required to be lined with geomembranes. Tailings dam footprints organically increase over the life of mine and so do the associated environmental risks and impacts. The construction and preparation of tailings dams is both costly and time consuming.

Solution

SoilTain Dewatering technology in conjunction with our reinforcement solutions, helps to reduce the required footprint areas of tailings dams which leads to lower required capital investment. Embankment and dyke construction with SoilTain Dewatering Tubes allow the incremental raising of tailings dams with a positive contribution to the environmental and economic sustainability of mining operations.

Your advantage:

- Tailings dam footprint reduction
- Stable embankment construction on geomembrane lined facilities
- Embankments can be incrementally raised to keep up with the safe rate of rise
- Utilisation of tailings/waste fill for embankment construction
- Improves tailings mechanical characteristics through encapsulation and confinement
- Reduced carbon footprint



Tailings Dam Capacity Increase

Challenge

When tailings dams reach their capacity the common solution is to build a new tailings storage facility. This creates new environmental risks, increases capital outlay and new land requirements.

Solution

Our sustainable waste storage solutions provide greater utilization of current waste disposal space through increasing vertical storage capacity of existing tailings dams using SoilTain Tubes, Fortrac geogrid reinforcement and Tektoseal Clay barriers.

Your advantage:

- Better utilization of waste material to construct stable embankments
- Efficient use of existing tailings dam footprint
- Reduction of environmental risk
- Reduction of capital and operational expenditure
- Increase of operational sustainability



SoilTain DW



Tektoseal Clay



Fortrac



Tailings Dams Embankment Stabilisation



Fortrac



Stabilenka

Challenge

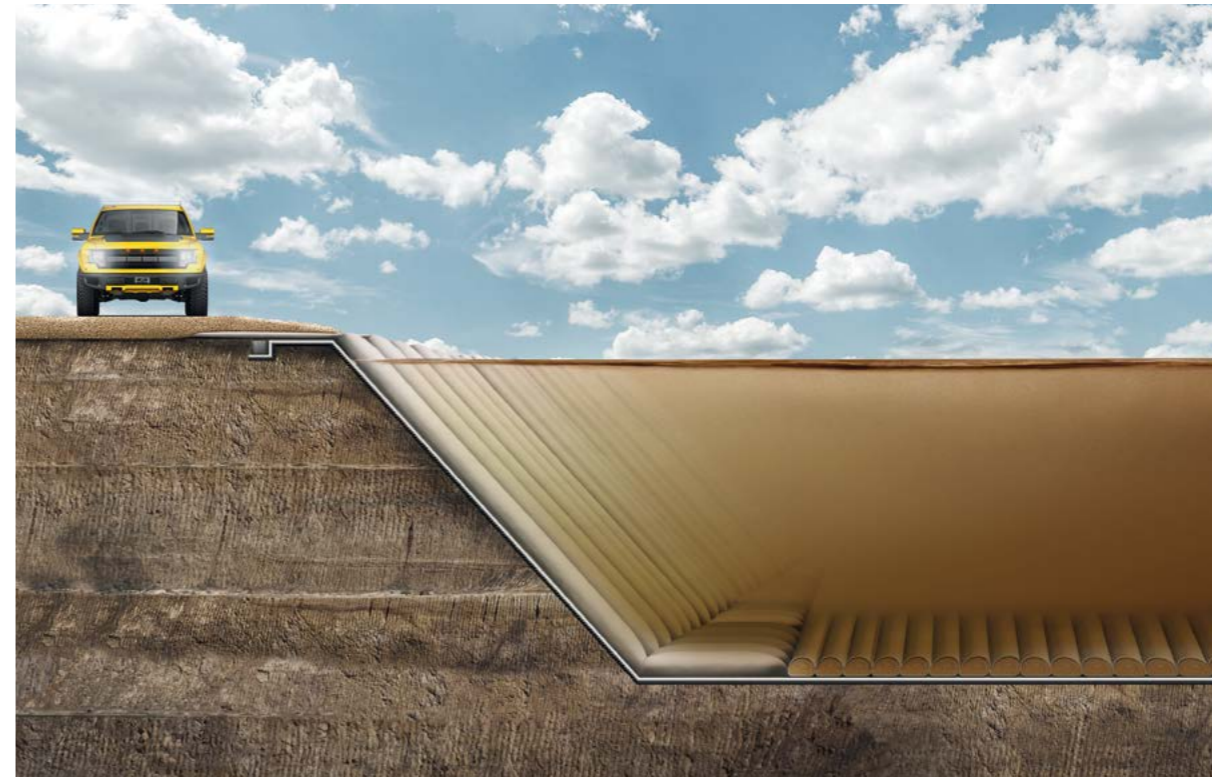
Conventional dams continue to be constructed to greater heights with greater storage volumes. However, the safety record of conventional dams has been steadily improving over the past 40 years, to the point that the probability of a conventional dam failure in any given year is roughly 1 in 10,000. This safety trend is unfortunately not yet the case for mine tailings dams, which are failing at a rate at least ten times higher than that of conventional dams.

Solution

Tailings dams currently have a higher profile within the mining industry compared to any other previous period. HUESKER studies each tailings dam project individually and offers dedicated analysis and embankment stabilisation design and supply capabilities, through the incorporation of superior flexible reinforcement geogrids and geotextiles. HUESKER's geosynthetic solutions are able to withstand and conform to the harsh environments in which tailings dams are often constructed.

Your advantage:

- Dedicated geosynthetic design capabilities
- Flexible reinforcement geogrids and geotextiles, which perform to the desired level even in the harshest conditions
- HUESKER collaborates with our clients, providing economical and environmentally sustainable design solutions
- The combination of responsible design and superior products reduces the risk of failure



Primary Barrier Protection

Challenge

Field research clearly shows a reduction in the mechanical and performance properties of geomembranes exposed to UV and solar thermal radiation. Consequently, the placement of cover layers on top of a primary geomembrane barrier has become common practice. Through eliminating UV and thermal exposure of geomembranes, the depletion of anti-oxidants out of geomembranes is slowed significantly, thereby extending the expected service life. However, the placement of traditional cover layers over geomembrane barriers is the largest cause of damage to liner integrity.

Solution

SoilTain Protect is an innovative geotextile containment system utilizing state-of-the-art weaving technology, which provides a tubular system interconnected into a singular geosynthetic mattress configuration which can be filled with waste product. The introduction of the SoilTain Protect cover layer means that no construction traffic is required on the cover which eliminates the greatest threat to the liner integrity during cover placement.

Your advantage:

- Elimination of heavy construction equipment on top of primary geomembranes
- Improvement of liner integrity
- Enhancement of site safety through reduction of construction traffic
- Increase of storage space due to utilization of waste (e.g. tailings, coal, ash) inside the protection tubes
- Reduction of capital expenditure
- Safe and efficient protection of environmental investment



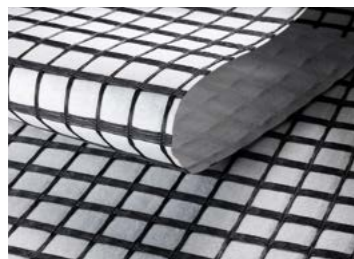
SoilTain Protect



Tektoseal Clay



Plant and Working Platform Stabilisation



Basetrac Duo



Basetrac Grid



Stablenka

Challenge

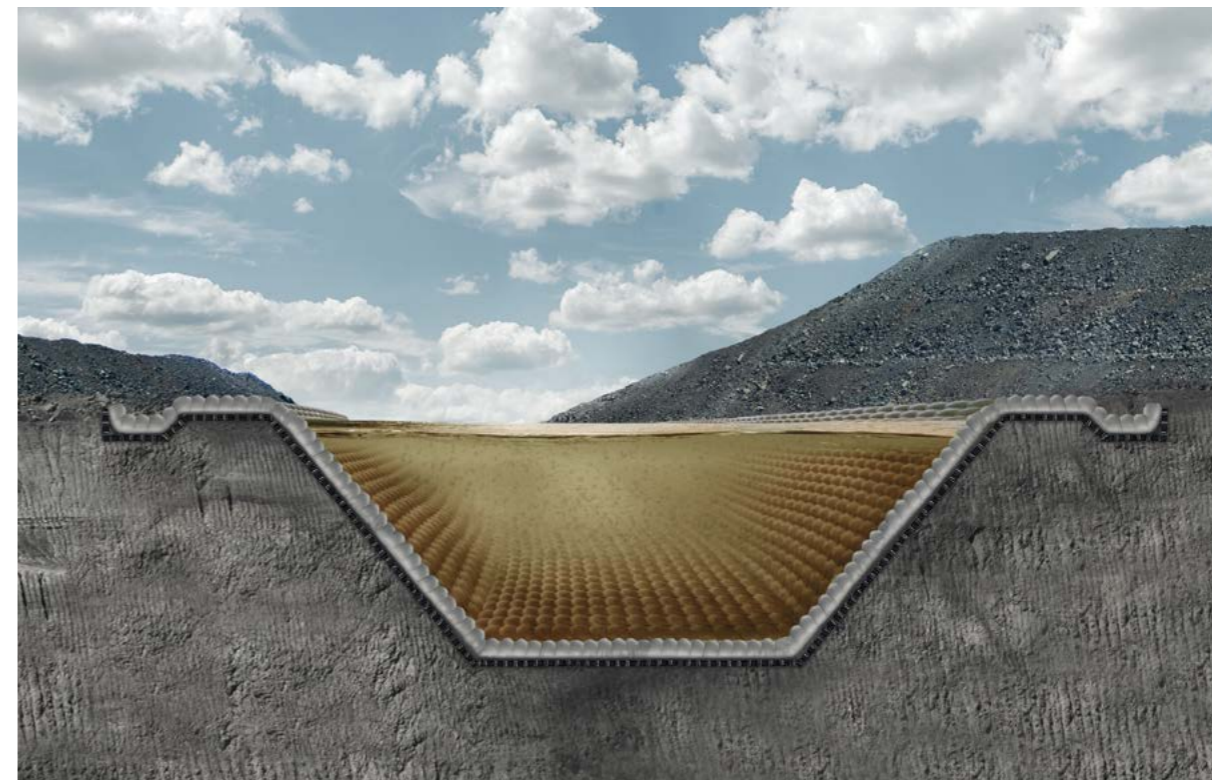
As ore body discoveries are made in more remote locations with increased areas of soft ground the requirement for safe, stable working platforms, temporary access road and permanent roads is proving more critical than ever.

Solution

Project specific geosynthetic design solutions from HUESKER provide superior structural integrity of foundation and basal layers within platform and road pavements. Our designs can assist with reducing the need for excavation of poor soils or hauling such materials from site. This saves valuable time and money.

Your advantage:

- Enhanced bearing capacity for very soft soils through the introduction of appropriate geosynthetic reinforcement
- Extended lifetime and reduction in maintenance
- Reduced requirement of imported construction materials
- Significant reduction of construction time
- Reduced carbon footprints due to thinner construction



Liquid Transportation

Challenge

Liquid transportation and containment structures are often constructed in remote areas where access is limited and the risk of vandalism of exposed waterproofing layers is high. The construction of traditional concrete structures is often expensive and time consuming.

Solution

Our Incomat product solutions offer comprehensive protection for liquid transportation and containment structures. The geotextile formwork acts as a surface sealing system while protecting against erosion, mechanical damage and buoyancy forces. The use of Incomat eliminates the need for conventional formwork erection, thereby cutting construction times and costs in comparison to more traditional methods. Thanks to its flexibility, Incomat adapts perfectly to the base, which is a particular advantage where varying profiles and surface characteristics are present.

Your advantage:

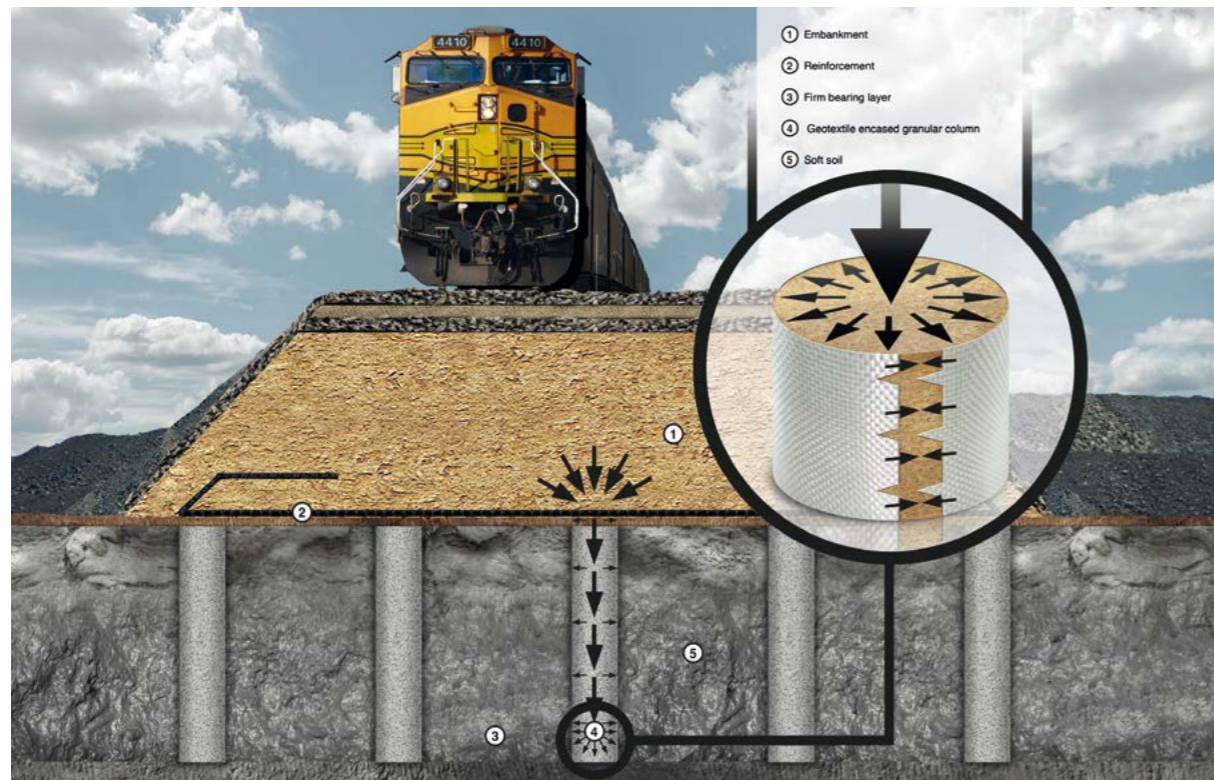
- Erosion and vandalism resistant
- Quick and practical installation
- Straightforward underwater installation (canal rehabilitation possible while facility remains in service)
- Easy installation over geomembrane barriers as protection layer



Incomat



Canal³



Road and Rail Construction on Soft Soil



Ringtrac



Fortrac



Stablenka

Challenge

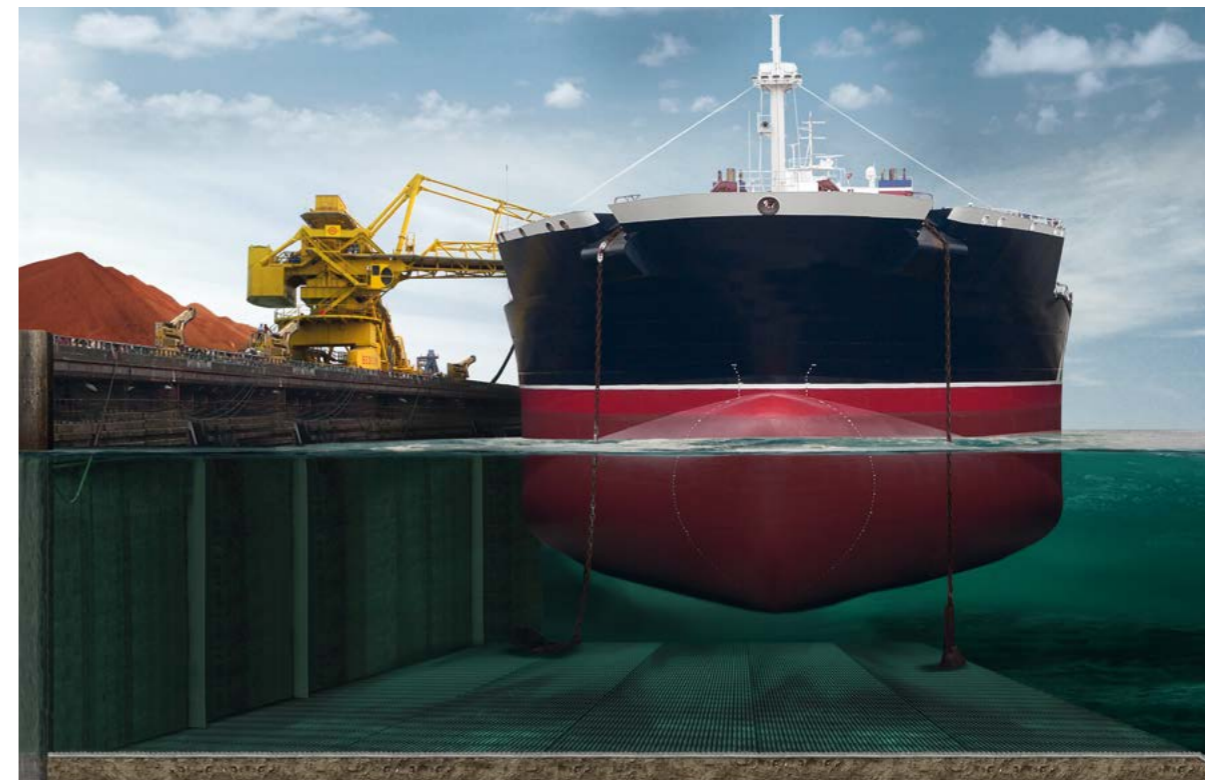
Transportation is a key infrastructural requirement for every mine. All kinds of operational materials and minerals have to be transported back and forth, very often passing challenging terrains including swamps. In many cases, the feasibility of projects can be negatively affected by the high construction cost of required infrastructure leading to and from mines over areas of problematic soils.

Solution

The Geotextile Encased Column (GEC) system Ringtrac was developed, with the assistance of HUESKER, as a foundation solution for earthwork structures built on very weak ground conditions. The key component in the innovative foundation system is the Ringtrac geotextile reinforcement sleeve. The Ringtrac sleeve is used to enclose non-cohesive material placed in a uniform arrangement of columns, which transmit the structural loads to the bearing stratum. The pile-like load-carrying system is a quick, cost-effective and very secure method of providing a foundation for embankments on very soft soils. Fortrac geogrids or Stablenka geotextiles are typically placed over the tops of the columns to assist with stability.

Your advantage:

- Fully loadable immediately after completion
- Short implementation time with very high base stability
- Highly adaptable to local conditions and loads
- No need to dispose of waste or contaminated spoil (where displacement installation method is used)
- Economical use of site space and lower excavation, disposal and imported material costs



Berth Protection and Scour Prevention



Challenge

Ports are typically used as the point of loading and export of a mine's mineral. A common challenge at the quayside is the wave and/or propeller scour of the sea bed adjacent to the quay wall and/or sloping jetty.

Solution

Incomat mattresses were developed by HUESKER engineers to provide a safe and cost-effective solution for berth and scour protection at ports. Incomat mats are deployed underwater and pump filled with highly fluid concrete to provide a scour protection apron.



Incomat

Your advantage:

- Creates robust interlocking concrete slabs underwater
- No rolling or sliding displacement
- Resists jet flows up to 12.5 m/s
- Reduced dredging and wall span height due to low mattress thickness (compared to traditional rock solutions)

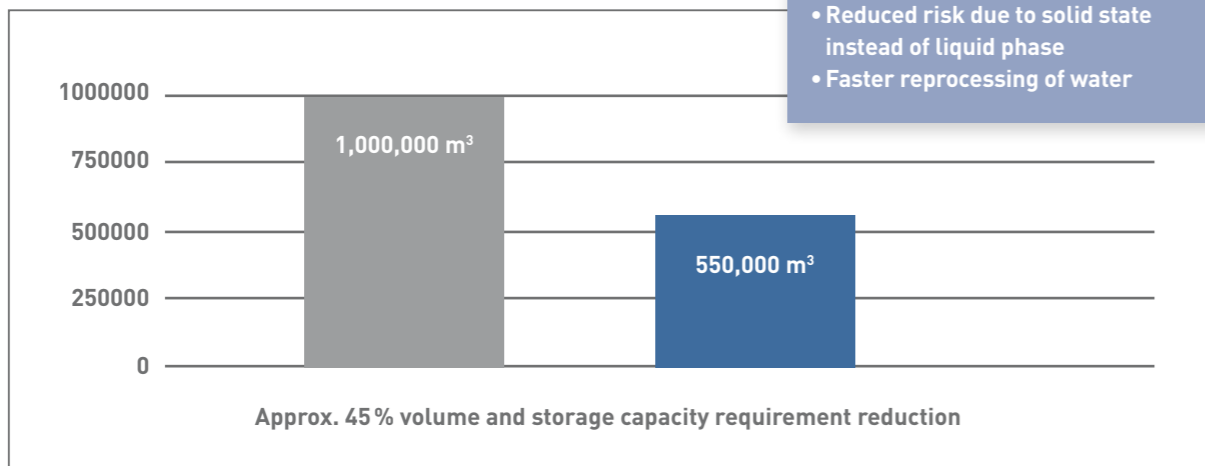
Examples of Geosynthetic Advantages



Tailings Volume Reduction Entire tailings feed to SoilTain Dewatering Tubes

Assumptions:

48% Dry solid content for conventional disposal
70% Dry solid content in SoilTain



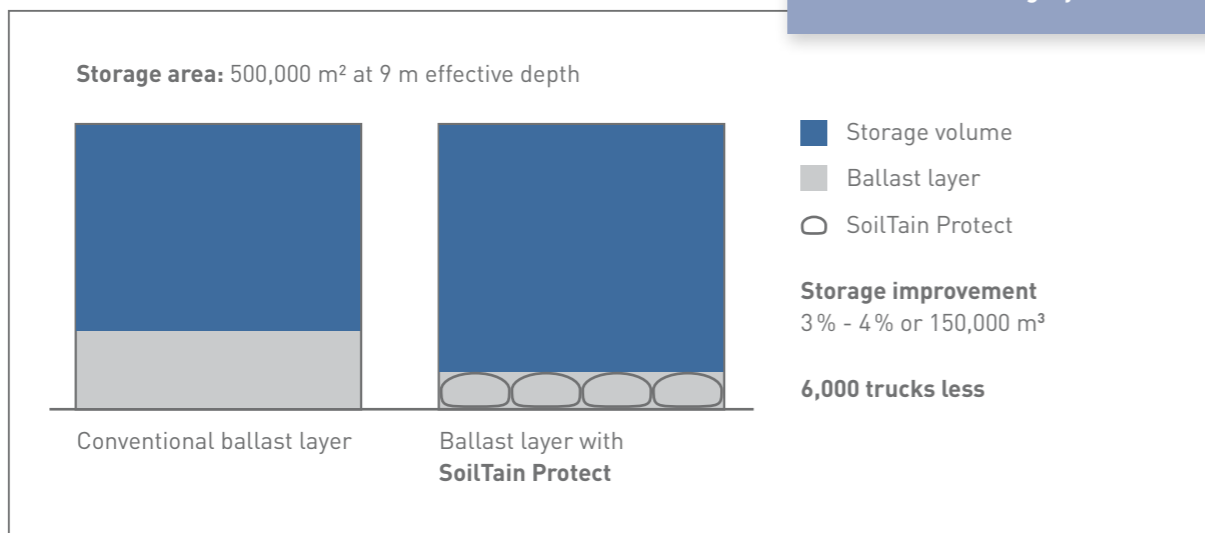
ADVANTAGES

- Reduced footprint
- Reduced risk due to solid state instead of liquid phase
- Faster reprocessing of water

■ Conventional or slightly thickened tailings ■ Tailings dewatered with SoilTain Dewatering Tubes

Tailings Volume Increase with SoilTain Protect

Replacing a 300 mm thick sand or soil protection/ballast layer with SoilTain Protect, the total facility storage volume is increased by 3% to 4%.



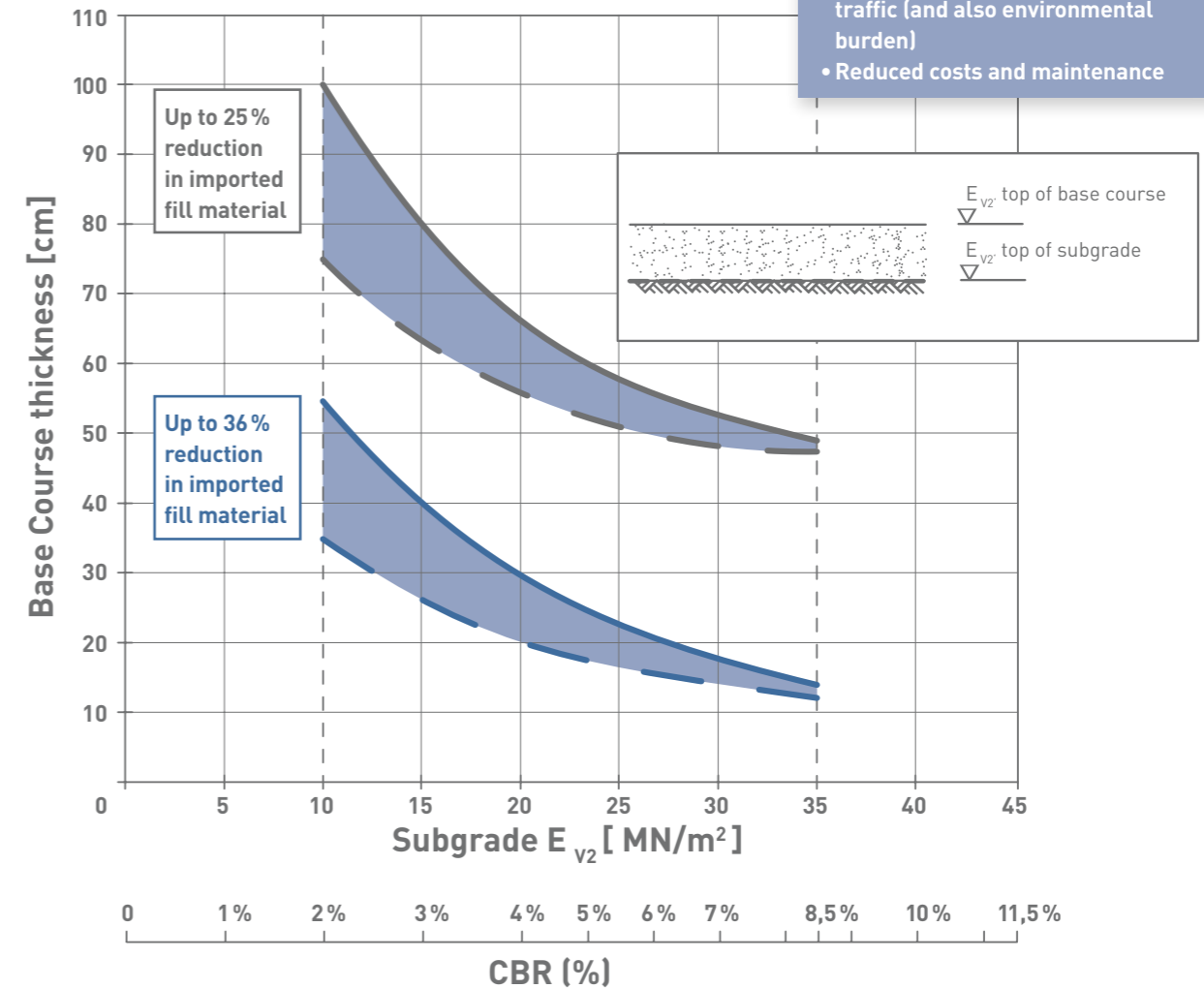
ADVANTAGES

- Less environmental impact (carbon footprint)
- Increased safety due to less traffic
- Increased liner integrity

Plant and Working Platform Thickness Reduction

ADVANTAGES

- Faster construction
- Increased safety due to less traffic (and also environmental burden)
- Reduced costs and maintenance

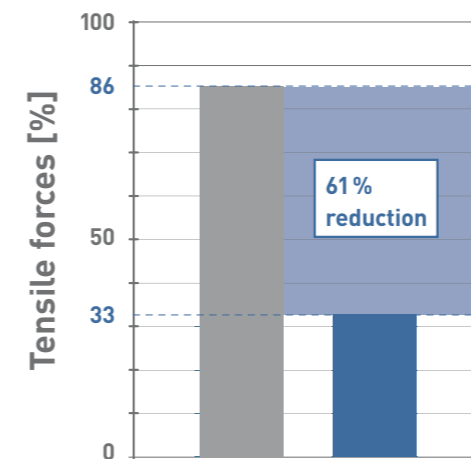


— E_{v2} at top of base course 120 MN/m² (unreinforced) — E_{v2} at top of base course 45 MN/m² (unreinforced)
 - - 120 MN/m² (reinforced) - - 45 MN/m² (reinforced)

Decoupling of Load from Geosynthetic Barriers

ADVANTAGES

- Increased (long term) safety
- Increased lifetime of barrier system



Assumptions:
30 m slope length
1:4 slope
60.7 kN/m load

Within the barrier layerworks a textured geomembrane carries 86% of the total tensile forces imposed on the slopes of the barrier system. When geogrid is incorporated on top of the barrier, the tensile force imposed on the barrier reduces to 33%.

■ Textured geomembrane with geogrid
 ■ Textured geomembrane without geogrid



Talvivaara Mine, Finland Gypsum Sludge Removal



Nickel and zinc are mined near the Finnish village of Kajaani at Talvivaara. The mine has a production capacity of some 10 million tons of ore per year. Previously, the large quantities of gypsum sludge arising during the mining operations had been deposited in lagoons.

A leak in one of the lagoons prompted the trial application of SoilTain Dewatering Tubes. The tests proved so successful that the tubes are now used for the disposal and permanent containment of all gypsum sludge generated at the mine. As the tubes are stacked in a five-layer pyramidal arrangement, the site space requirement is greatly reduced compared to the original lagoon storage concept used.

FACTS

- Dewatering of large quantities of gypsum sludge
- Safe permanent containment of sludge cake
- Following successful trials, system now used for entire production



Companhia Siderúrgica do Atlântico (CSA) Plant, Brazil Soil Improvement in the Stockyard Area

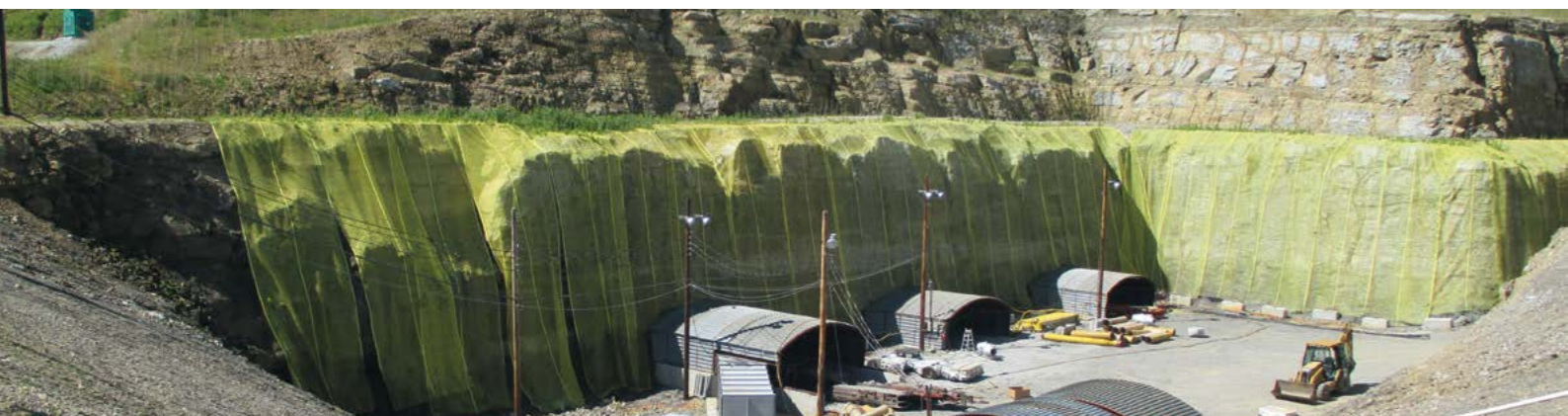


The CSA plant is owned by ThyssenKrupp/Vale and located on the coastal area of Sepetiba Bay in Rio de Janeiro, Brazil. The low bearing capacity of the soils coupled with the high risk of flooding required the construction of an elevated 1.5 to 2.0 m thick platform.

A total of 270,000 linear metres of Ringtrac Geosynthetic Encased Columns and over 1 million m² of geotextiles and geogrids were installed for the horizontal reinforcement of the storage yards, thus making this the biggest project in Brazil for the use of geosynthetics in engineering for soil reinforcement.

FACTS

- More than 1 million m² of geosynthetics
- 270 km Geosynthetic Encased Columns
- Largest engineered geosynthetic project in Brazil to date



Coal Mine, USA Highwall Protection



A new coal mine in Northeastern Ohio, USA, had to protect workers and equipment from loose rock in a highwall surrounding their new belt, air, and equipment entries. Installation would be carried out from mobile equipment (cherry pickers) from the toe of the highwall. The barrier used to cover the highwall had to be pliable enough to conform to the irregularities in the rock face to minimize movement behind the barrier, yet strong enough to withstand the forces of falling rock, some as large as 30 cm in diameter. Minegrid was the perfect choice because of its high strength and low weight, combined with resistance to corrosion and UV degradation.

FACTS

- Project completion ahead of schedule, with no injuries
- Installation with mobile equipment
- Increased site safety



Maraca Mine, Brazil Primary Dump Wall



Alto Horizonte is a city in the state of Goiás approximately 350 km away from Goiânia in Brazil. For the installation of the primary stone crusher a 15 m high vertical retaining wall was designed to support an equivalent load of up to 100 kN/m² applied on the top of the wall by heavy mining equipment.

The construction technique comprised a vertical reinforced soil structure with alternating layers of Fortrac geogrid and compacted fill with a shotcrete facing. The structure is capable of supporting high operational loads under low serviceability strains. The retaining wall was built with fill material from a local mine and supported by a backfilled and compacted foundation.

FACTS

- 15 m high wall with 25 layers of Fortrac geogrid
- Use of locally available fill material
- Fortrac stiffness modulus from 400 kN/m to 1,500 kN/m (at 5% strain)

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HUESKER Synthetic is certified to ISO 9001 and ISO 50001.



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