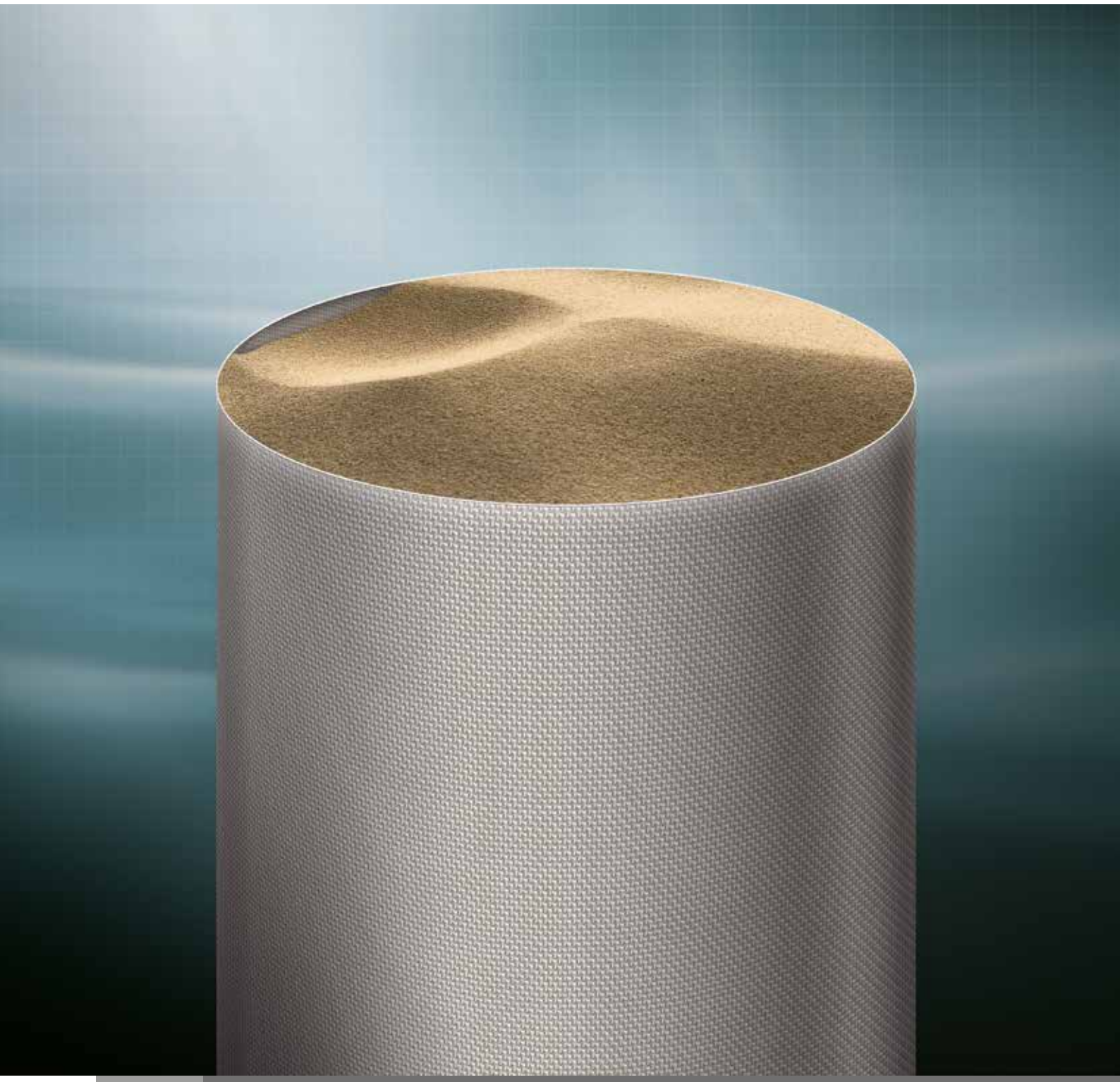


Ringtrac®

Reliable Ground Improvement for Weak Soils

HUESKER
Ideen. Ingenieure. Innovationen.

Reliable Ground Improvement

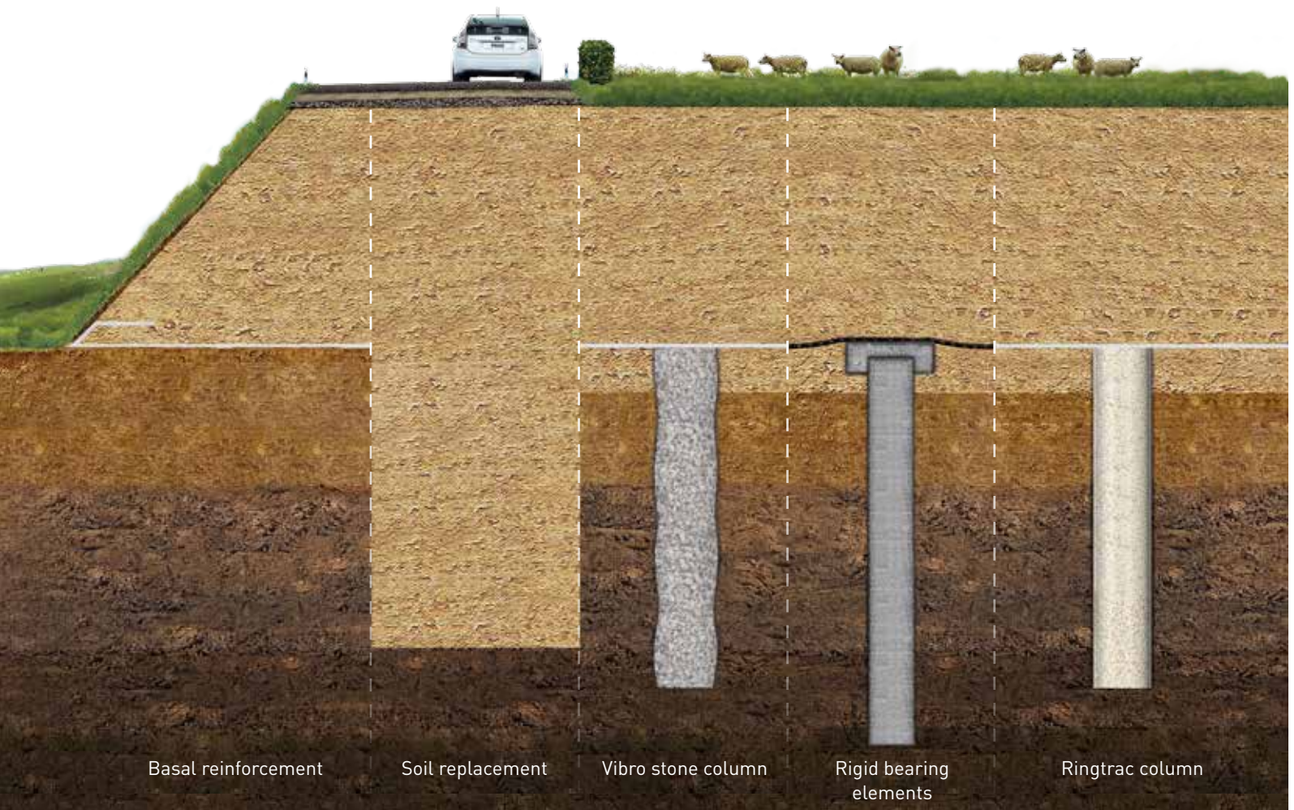
Particularly for Soils with very low Bearing Capacity

Challenges and goals

The design of reliable embankment foundations on weak soils pose a major challenge. In addition to large-scale settlement and lateral deformation, potential risks include bearing and slope failure, or even the squeezing-out of soil from beneath the embankment base.

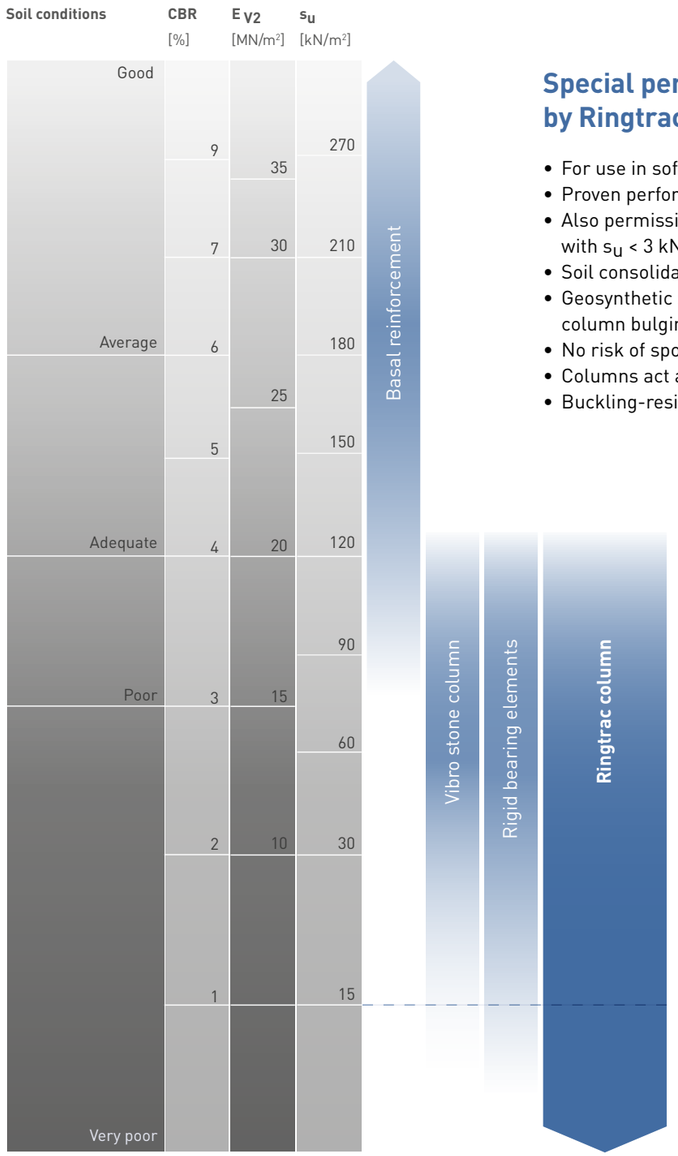
- High stability during and after construction
- Reliable performance, even in very soft subsoil
- Accommodation of high loads from embankment
- Minimisation of settlement
- Rapid construction of high embankments without risk of bearing failure
- Adaptable to local conditions and loads
- Full loadability immediately after completion
- Reduction of horizontal pressure in soft soil

Methods of constructing embankment foundations



Comparison of methods and solutions

Selection of the most suitable foundation method is dictated by the soil conditions, loads and requirements placed on the structure. Key parameters for describing the soil conditions include the CBR, E_{V2} and s_u. Ringtrac-encased columns offer the only means of providing reliable foundations in soft strata with $s_u < 0.5$ kN/m².



Special performance features offered by Ringtrac columns

- For use in soft strata with $s_u < 15$ kN/m²
- Proven performance for $s_u < 0.5$ kN/m²
- Also permissible under EBGEO for use in soils with $s_u < 3$ kN/m²
- Soil consolidation largely during construction period
- Geosynthetic casing prevents loss of column material and column bulging action, even where lateral support is lost
- No risk of spontaneous failure thanks to high ductility
- Columns act as megadrains
- Buckling-resistant

BENEFITS

- Suitable for soft strata with s_u < 15 kN/m²
- Filtration stability between adjoining ground and column fill
- No column failure due to bulging/shear/buckling action
- High system redundancy
- High ductility
- Megadrain
- Cost-effective thanks to use of locally sourced fill materials

The Geotextile-Encased Column

Column Integrity for Load Transmission in Extra-Soft Soils

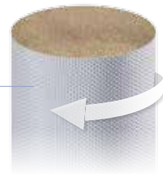
Innovative foundation

The Ringtrac foundation system takes the form of a regular arrangement of columns comprising non-cohesive material placed inside a geosynthetic casing. The geotextile-encased column represents an improvement of the vibro stone column. The structural action of the geotextile casing transforms granular columns into efficient loadbearing elements. The columns can be installed more or less independently of the level of lateral support provided by the soft strata to create a ductile structural system.

How the system works

All the actions and stress concentrations on the column heads induce outwardly directed, radial stresses within the columns. The particularity of the system is that these stresses are counteracted not only by the inwardly acting earth pressure of the soft soil stratum, but also by the radial resistance of the high-modulus geotextile casing. In the course of consolidation, the circumferential tensile forces mobilised in the casing bring about an increase in column stiffness and thus a concentration of loads above the columns.

Ringtrac-encased columns are used in extremely soft ground, such as peaty or alluvial soils with s_u < 15 kN/m² and very low lateral support. Standard applications are for soils with s_u between 3 and 30 kN/m². Under the EBGEO ("Recommendations for Design and Analysis of Earth Structures using Geosynthetic Reinforcements"), they may also be used in soils with s_u < 3 kN/m².



Casing

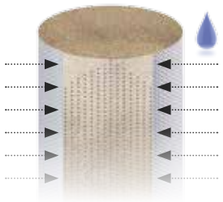
- Seamless thanks to special circular-loom technology
- PET or PVA as raw material
- Circumferential tensile strength up to 600 kN/m
- Radial stiffness of up to 7,000 kN/m

Column size

- Diameters from 0.4 m to 1.0 m
- Long columns over 30 m possible
- Easy on-site customisation

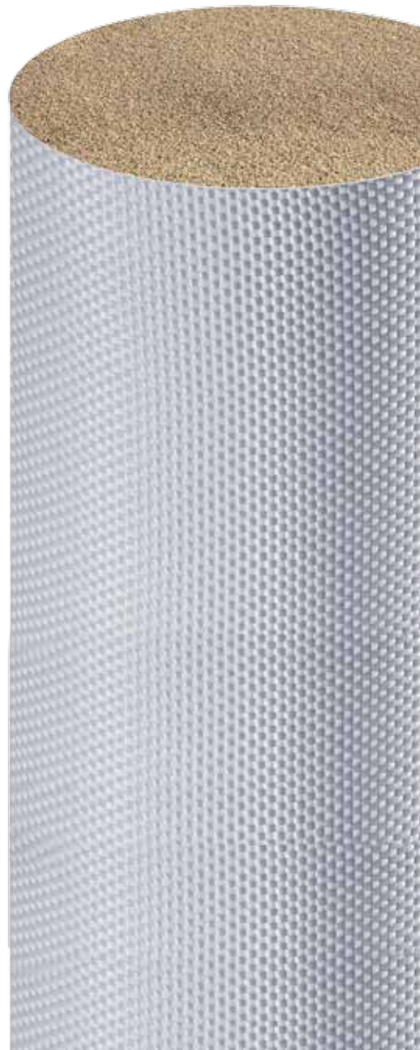
Fill

A wide variety of locally sourced materials can be used for in-situ filling of the geotextile casing (sand, gravel, crushed stone, recycled material etc.).



Drainage function

Ringtrac columns take in water over their entire surface. This speeds up the consolidation process.



The Geotextile-Encased Column System

How the system works

The columns ensure that the structural loads are transmitted through the weak subsoil to a stratum with adequate bearing capacity. The system's high ductility enables it to accommodate fluctuations in actions and soil properties through load redistribution.

Applications

- Standard road and rail embankments
- Land reclamation
- Dams and dikes
- Road and rail access for mining
- Improvements to liquefaction-prone soils

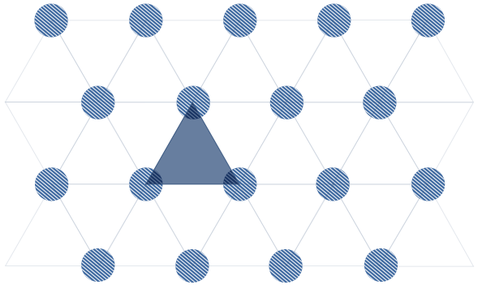
Up to
50 %
fewer columns
compared to ground improvement with vibro stone columns

The following design parameters can be used to adapt the system to virtually any construction application

- Circumferential tensile strength and/or tensile stiffness
- Area replacement ratio (10-20 % column proportion)
- Diameter (between 40 and 100 cm)
- Raw materials (PET and PVA)
- Depth
- Installation method
- Surcharging

Column grid

A triangular column grid is typically adopted for maximum efficiency in strengthening the soft soil.



Horizontal reinforcement

The horizontal reinforcement above the columns facilitates the transmission of structural loads to the columns and promotes global structural stability. It helps to even out any resulting settlement while accommodating lateral spread.

- Separation and filtration function prevents mixing of soft subsoil and embankment material
- Cost-effective, single-layer reinforcement made possible by extremely high tensile strengths
- High tensile strength allows maximisation of column grid size

Design

The design is based on verified information provided by the client regarding soil parameters, geometries and loads. The data can be used for computation of the Ringtrac columns and vertical stability with HUESKER's RingtracS software. The stability of the embankment structure and consolidation period can also be calculated. The design procedure is set out in Section 10 of the EBGEO.

Fast and Easy Installation

Three Established Installation Methods

Displacement method

Most common installation method whereby circumferential tensile forces are activated under imposed loads (embankment etc.).

- Steel tube with closing base flaps
- Tube sunk to bearing stratum
- Geosynthetic casing inserted into steel tube
- Casing filled with granular and non-cohesive material, e.g. sand, gravel, crushed stone and recycled material
- Steel tube withdrawn from ground under vibration
- Circumferential tensile forces activated by column expansion under imposed loads

Replacement method

Low-impact installation method with no dynamic effects on surrounding area. Circumferential tensile forces are activated under imposed loads (embankment etc.).

- Open steel tube
- Tube sunk to bearing stratum
- Soil extracted from steel tube
- Geosynthetic casing inserted into steel tube
- Casing filled with granular and non-cohesive material, e.g. sand, gravel, crushed stone and recycled material
- Steel tube withdrawn from ground under vibration
- Circumferential tensile forces activated by column expansion under imposed loads

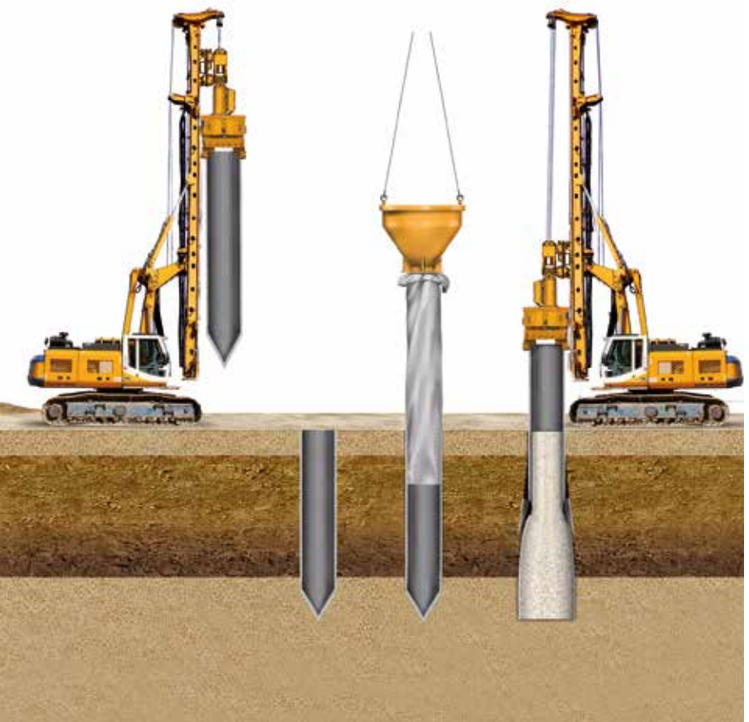
Vibro Displacement method

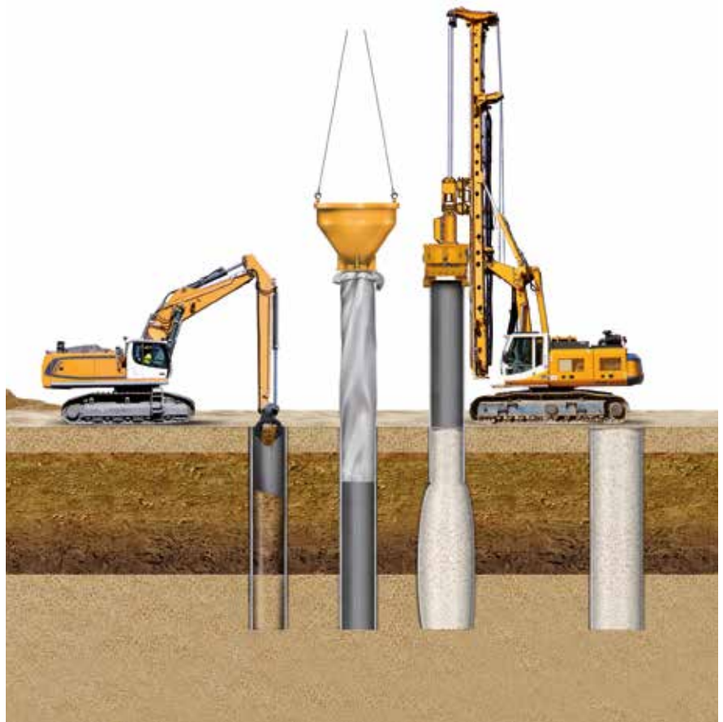
Most recent installation method whereby circumferential tensile forces are already partially activated during installation.

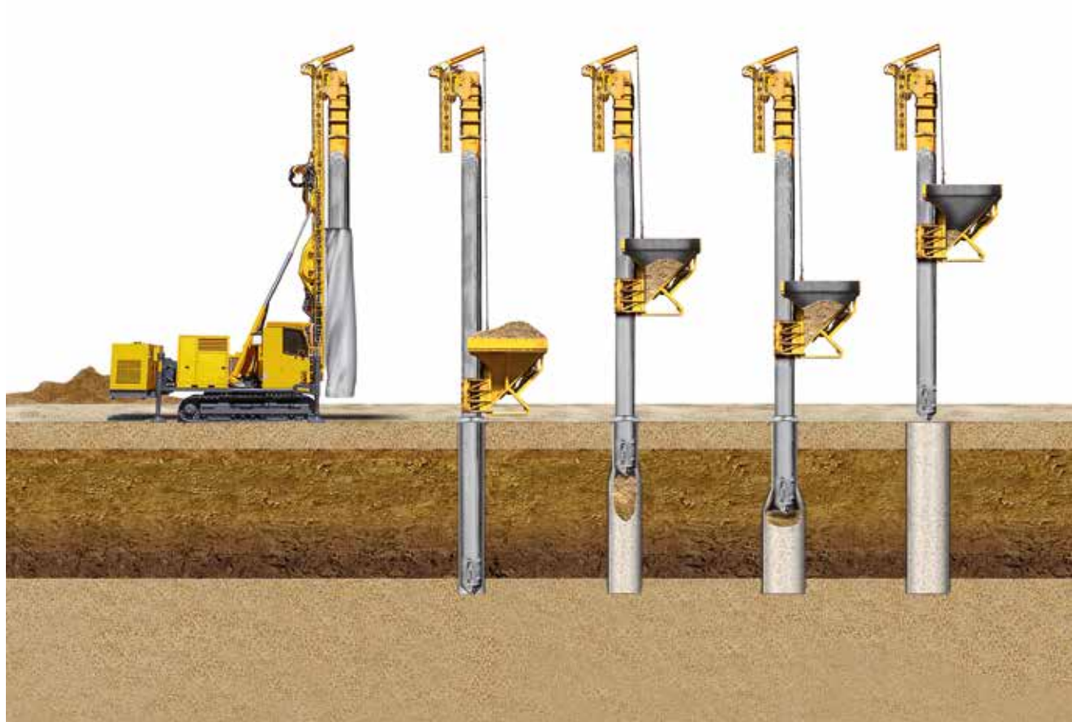
- Geosynthetic casing fitted to bottom-feed vibrator
- Tube sunk to bearing stratum
- Bottom-feed vibrator gradually withdrawn from ground
- Column simultaneously filled with sand, gravel, crushed stone or recycled material
- Compaction by repeated lowering of vibrator
- Circumferential tensile forces thus already partially activated during installation

BENEFITS

- Three installation methods available
- Over 20 years of installation experience
- Globally established and implemented (e.g. by STRABAG, ZÜBLIN, KELLER)
- On-site advice by our applications engineering department
- Traffickability and stable base for plant/ equipment during construction phase







Key Ringtrac System Benefits at a Glance

Reliable

- Suitable for extremely soft soils
- 50-75 % reduction in creep settlement
- Dynamic loads (e.g. from passing trains) accommodated without damage
- Adjacent buildings unaffected by settlement
- Neighbouring structures shielded from horizontal pressure
- Full loadability immediately after completion
- Adaptability to local conditions and loads
- Permeability of weak subsoil maintained
- Suitable in conjunction with confined groundwater thanks to base seal

Fast

- Almost all settlement takes place within construction period
- Up to 50 % fewer columns than with vibro stone column solution
- Accelerated consolidation
- Rapid construction of high embankments without risk of bearing failure
- Straightforward adjustment of column length to subsoil conditions

Cost-effective

- Use of locally sourced soils as column fill
- Low requirements placed on fill materials
- High level of certainty in costing and construction
- Lower area replacement ratio and post-construction settlement
- No need to dispose of waste or contaminated soil
- Economical use of site space and lower excavation, disposal and imported material costs

Cost-neutral
in direct comparison to vibro stone columns

Study on ground improvement methods for embankment foundations in weak organic soils
(Küster & Petereit Ingenieure GmbH, Elmshorn, Germany, 2017)

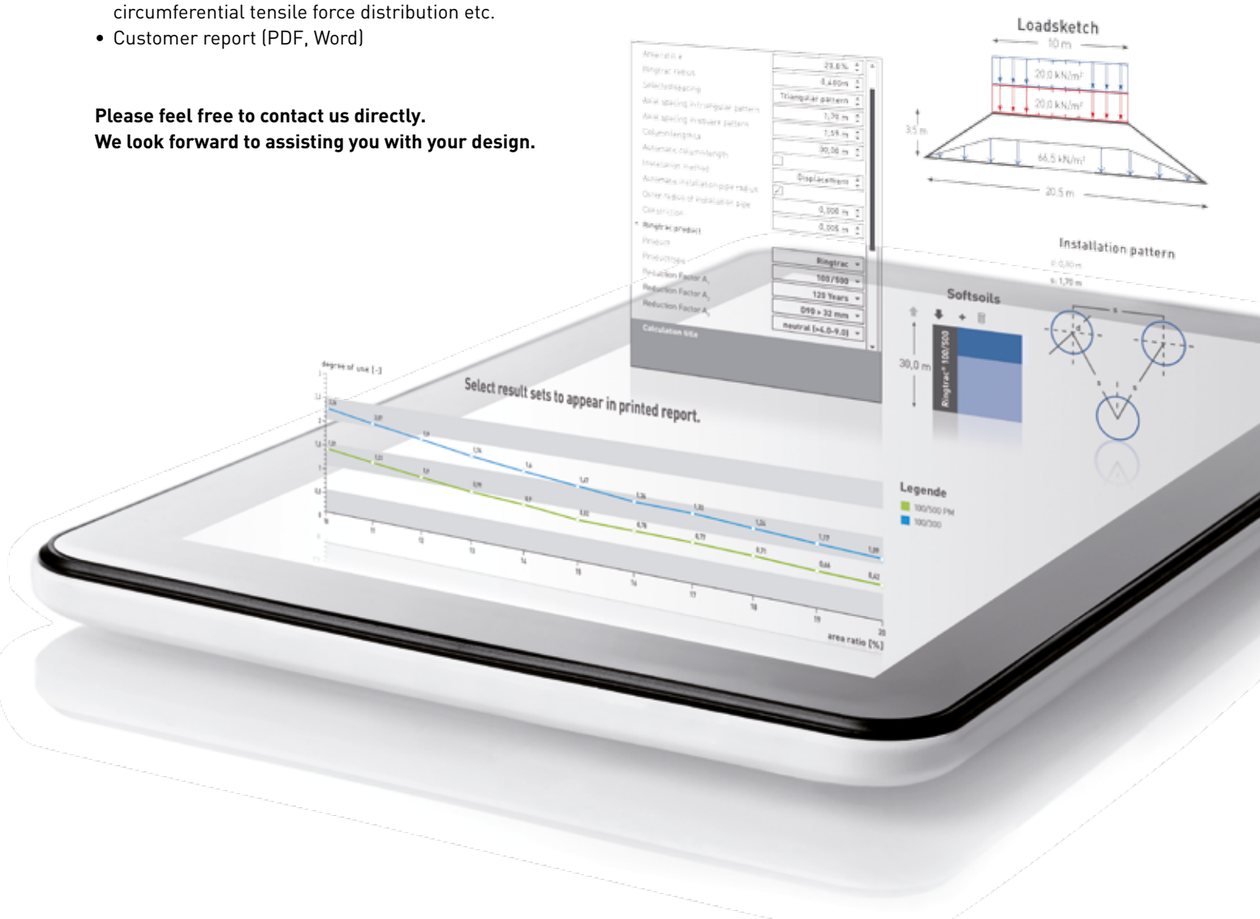
HUESKER RingtracS software
Reliable design to meet any challenge

RingtracS is a design software application purpose-developed by HUESKER's engineers. It ensures the reliable project-specific design of Ringtrac system solutions with due allowance for all relevant parameters.

Integral computation

- Allowance for multi-layer subsoil profiles
- Parallel calculations for varying cross-sections and system parameters
- Allowance for load distribution
- Determination of equivalent cohesion for calculating global structural stability
- Automatic settlement compensation
- Provision for factoring in strain-dependent stiffness
- Parametric studies and graphic representations for settlement, circumferential tensile force distribution etc.
- Customer report (PDF, Word)

Please feel free to contact us directly.
We look forward to assisting you with your design.



Application Examples

Kirsehir

Turkey, 2012 – 2014, underwater foundation for 20 m high traffic embankment in earthquake region. Installation at up to 7 m water depths.

Rio de Janeiro

Brazil, 2006 – 2010, foundation system for thick, soft, waterlogged soil stratum with low bearing capacity by Sepetiba Bay. The approx. 900 ha site was used to build a new steel mill.

Mühlenberger Loch

Germany, 2001 – 2003, extension to DASA Airbus plant at Hamburg-Finkenwerder, made possible by reclamation of 140 ha of land directly by River Elbe. The overall foundation system incorporated 60,000 geotextile-encased columns for a 2.4 km long dike.

Poland, A2 motorway

Poland, 2010 – 2011, construction of embankment with 3,400 Ringtrac columns for A2 motorway near Jordanowo. With a length exceeding 30 m, these were the longest geotextile-encased columns installed to date.

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.

Engineering Services

- **Technical consulting**
  We will recommend the appropriate product types for your specific requirements.
- **Technical design**
  Our engineers assist design practices by performing verifiable design calculations in accordance with international codes of practice.
- **Project-specific placement plans**
  We will prepare installation and placing recommendations plus installation diagrams.
- **International knowledge transfer**
  Best-practice solutions and techniques from our global network.

Product Services

- **Custom-designed product solutions**
  We will assist 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**
  Product and application-specific instruction.

Documents

- **Certificates and approvals**
  Our products have numerous certifications that are issued, for example, by BAM, BAW, BBA, EBA, IVG and SVG, depending on the product type.
- **Tender documents**
  We would be happy to provide you with proposals for your specification texts.
- **Technical guidelines**
  Technical guidelines will help you to ensure the best practice installation of your product on site.

Digital

- **Website**
  Here, we offer you news, videos, project reports, installation guidelines, specialist articles, scientific publications, software, brochures and much more.

You will also find us on Facebook, LinkedIn and YouTube.

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