BENDA Trade

Patented method
for foundation engineering

BENDA Trade

CONTENT

BENDA Trade

INTRODUCTION

COMPANY'S HISTORY, COMPANY PROFILE, ACTIVITIES, DIVISIONS, PATENTS, CERTIFICATES

BENDA Trade

…the company that launched GEOCELL product in the Czech and Slovak markets, an innovator and owner of several patents, owner of an ultrasonic production line, penetrating the US market with the American patent US 7,431,536 B2…

www.benda-trade.cz

COMPANY'S HISTORY

2000 – 2009

- Company established.
- Sole distributor; GEOCELL product (cellular confinement system, geocell) launched on the Czech and Slovak markets.
- Building works including full technical and geotechnical support.

2003

- Start of research, development and innovation of the cellular confinement system (geocell).
- A method of building flat foundations for floors – WEBFLOOR®.
- Utility model No. 13384 for the Czech Republic.
- Application for PCT/CZ 2003/000051 – US patent pending.

2004

- Utility model No. 3775 for the Slovak Republic.

2006

- Czech PATENT No. 296488.
- Start of cooperation with European Union funds.

2008

- USA PATENT – US 7,431,536 B2 (method of building a flat foundation for a floor) issued at the name of the company's executive – Ing. Jiri Benda.
- A new ultrasonic cellular confinement system (geocell) production line purchased.
- New utility models No. 18528 and 18456 for the Czech Republic obtained, new patents applied for in the Czech Republic.
- New applications for utility models in the Slovak Republic, new patents applied for in the Slovak Republic.
- New international PCT applications.

2009

- The division penetrates the US market.
- Application for US PATENT - US 7,431,536 B2.
- International legal intellectual property protection.
- Development of activities connected with research, development and innovation.
- Research, development and innovation centre for construction testing.

BENDA Trade

Dear friends,

Our company launched GEOCELL on the Czech and Slovak markets. Delivery of our products includes installation and full technical and geotechnical support. Research, development and innovation are our main priorities. We hold several notable patents. In 2006, we began cooperating with European Union funds, with the objective of supporting development of our patent for the CR No. 296488. In 2008, we bought an ultrasonic line for the production of the cellular confinement system (geocell). We will consider your concrete requests on quality / price and provide you with our product from the Czech Republic, or we will recommend and mediate your purchase with our foreign partners.

On October 7, 2008 I, as an individual, obtained US patent No. US 7,431,536 B2, for the whole territory of the United States of America, for my method of building flat foundations for floors. In 2009, our BENDA TRADE division penetrated the USA market with the objective of applying this American patent. To provide for the protection of our intellectual property, we started our cooperation with an international law firm in 2008.

Ing. Jiri Benda
CEO

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BENDA TRADE IN CR

- ## RESEARCH, DEVELOPMENT AND INNOVATION
  These are our major priorities. We are planning to start establishing a research, development and innovation centre for construction testing in 2009.

- ## INDUSTRIAL PROPERTY PROTECTION
  We protect the results of our research and development with legal industrial protection and subsequently apply them in the field.

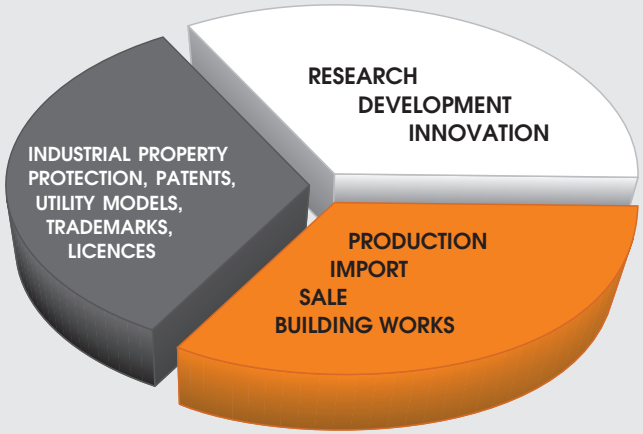
- ## PRODUCTION
  In 2008, we bought a cellular confinement system (geocell) production line, utilizing ultrasonic technology from the Herrmann Ultraschalltechnik Company.

- ## IMPORT
  A part of our demand is covered by imports from our foreign partner.

- ## SALE
  We sell our products including installation.

- ## BUILDING WORKS
  We provide our products including technical and geotechnical support (see our projects).

Sample of an ultrasonic technology from
The Herrmann Ultraschalltechnik Company



DIVISION BENDA TRADE USA

BENDA Trade

USA PATENT – US 7,431,536 B2

SPECIFICATION OF THE US PATENT – US 7,431,536 B2

- COMMERCIAL NAME OF THE PATENT: WEBFLOOR®
- DESCRIPTION:

An advanced method for foundation of floor construction in industrial and residential buildings in standard geological environment, as well as difficult geotechnical foundation conditions.

- MAIN ADVANTAGES:
  a) significant savings in costs for floor foundations
  b) reduction in costs of floor construction
  c) minimization of future risks of damage to the floor construction, such as:
    - excess settlement
    - differential settlement (shifting of levels)
    - permanent floor failure
- APPLICATION:

  The patent can be applied especially for floor foundations for hypermarkets, supermarkets, warehouses, cold storage buildings, shopping malls, residential buildings etc.

- AREA OF UTILISATION: The whole territory of the USA
- GRANTED ON: October 7, 2008
- PATENT'S OWNER: Ing. Jiri Benda – executive of BENDA TRADE s.r.o.

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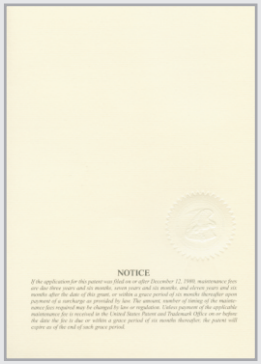
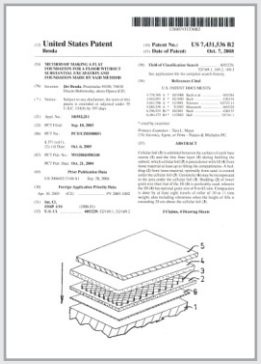
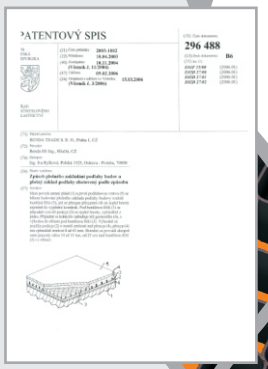
INDUSTRIAL PROPERTY PROTECTION
NEW PATENTS AND UTILITY MODELS

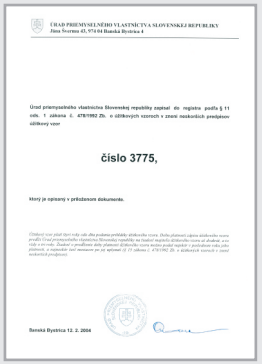




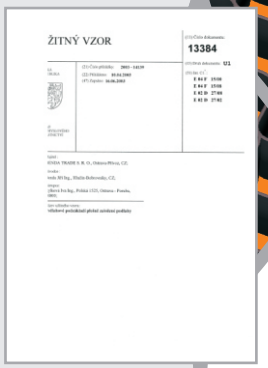
US PATENT US 7,431,536 B2

CZECH PATENT No: 296488



CERTIFICATE OF UTILITY MODEL REGISTRATION IN SR No: 3775



CERTIFICATE OF UTILITY MODEL REGISTRATION IN CR No: 13384

We have several international PCT patents pending for our new applications.
Our company also owns several trademarks.

PLEASE NOTE THAT OUR SOLUTIONS ARE INDUSTRIALLY PROTECTED. SOLUTIONS UNDER INDUSTRIAL PROPERTY PROTECTION CANNOT BE USED WITHOUT THE OWNER'S CONSENT. IN CASE OF UNAUTHORIZED USE THE MISUSER RUNS THE RISK OF PENALTY UNDER THE LAW.

INDUSTRIAL PROPERTY PROTECTION
NEW PATENTS AND UTILITY MODELS

BENDA Trade

CERTIFICATE OF UTILITY MODEL REGISTRATION IN CR No: 18528

CERTIFICATE OF UTILITY MODEL REGISTRATION IN CR No: 18456

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TECHNICAL AND TEST INSTITUTE FOR CONSTRUCTION PRAGUE

(TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.)

PRODUCT
CERTIFICATE
No: 030 – 034005

CERTIFICATE
of conformity
No: 030 – 038235

CERTIFICATE
No: 030 – 034040

REPORT on results of
factory production
control assessment
No: 030 – 034039

REPORT on product
certification results
No: 030-034038

REPORT ON SUPERVISION
of certified product
No: 030-038236

With every delivery, the seller BENDA TRADE s.r.o. will submit the Declaration of Conformity pursuant to s. 13 of the Act No. 22/1997 Coll., on Technical Requirements for Products and s. 13 of government regulation No. 163/2002 Coll., as amended by No. 312/2005 Coll., concerning Technical Requirements on Selected Construction Products.

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PRODUCT

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PRODUCT

... is a system of smooth, surface-patterned (textured) or perforated PE–HD strips (50, 75, 100, 150, 200, 250 mm in depth) connected in a series with collateral root penetrations vertical to the longitudinal axis. After dilatation and stabilization, the connected strips form...

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CELLULAR CONFINEMENT SYSTEM (GEOCELL) FOR STRUCTURAL AND CIVIL ENGINEERING

1) GENERAL SPECIFICATION

Cellular confinement system (geocell) is a system of smooth, surface-patterned (textured) or perforated PE–HD strips (50, 75, 100, 150, 200, 250 mm in depth) connected in a series with collateral root penetrations vertical to the longitudinal axis. After dilatation and stabilization, the connected strips form walls of spatial flexible cells. Subsequently, these cells are filled with filling material (chosen according to the purpose of use and surface load): sand, gravel, earth, crushed stone, concrete, refuse excavated from the construction site, etc.

2) PRINCIPAL UTILISATION

a) **Subbase confinement**
foundations of industrial and residential buildings
foundations of civil structures – highways, roadbed.
b) **Stabilization of slopes affected by surface erosion.**
c) **Stabilization of stream channels and ditches.**
d) **Construction of retaining walls.**

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Higher parameters of strength and deformation of the pit base.
- Exclusion of excess values of differential settlement.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day.
- Manual placing without using machinery.
- Possibility to use the original refuse excavated from the site.

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INSTALLATION INCLUDING TECHNICAL AND GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

Apart from building works, it is our standard to provide the following services:

Preparatory works:

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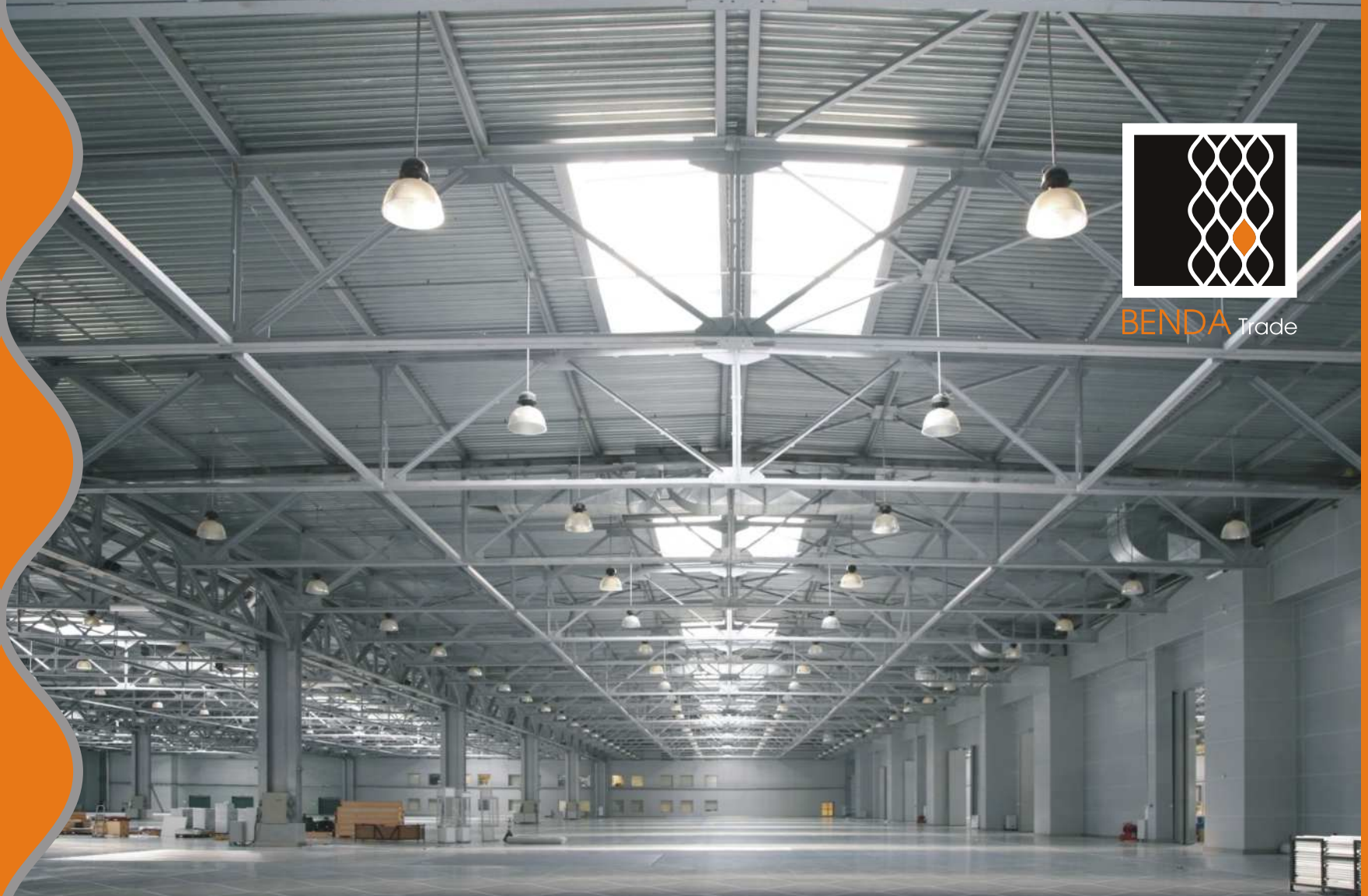
- An unambiguously defined method for building the foundations.

Implementation phase:

- Technical supervision during the construction process.

Upon client's request, we are also able to ensure:

- Assessment of reliability of the designed construction both analytically and numerically, via simulation of the tense-deformation state by the variation finite element method.
- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.



BENDA Trade

WEBFLOOR®
PATENTED METHOD
FOR FLOOR FOUNDATION

WEBFLOOR

BENDA Trade

WEBFLOOR®

PATENTED METHOD FOR FLOOR FOUNDATION

WEBFLOOR

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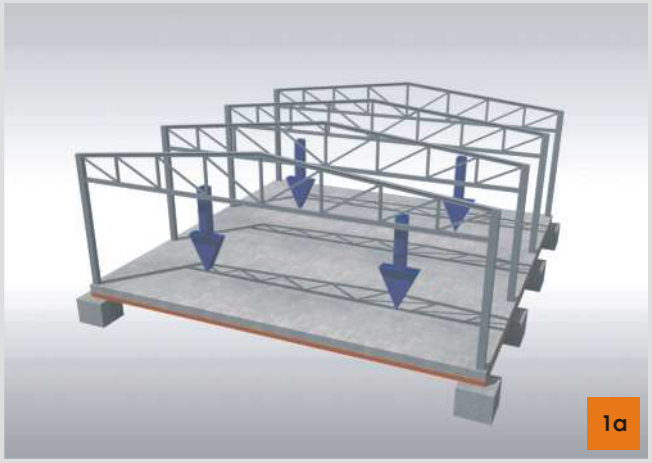
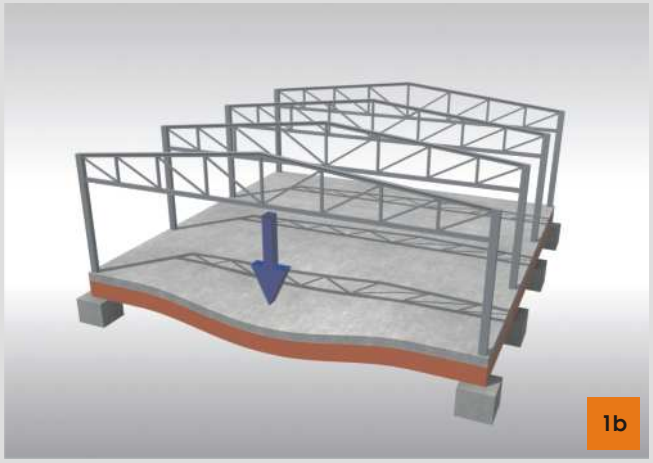
WEBFLOOR®

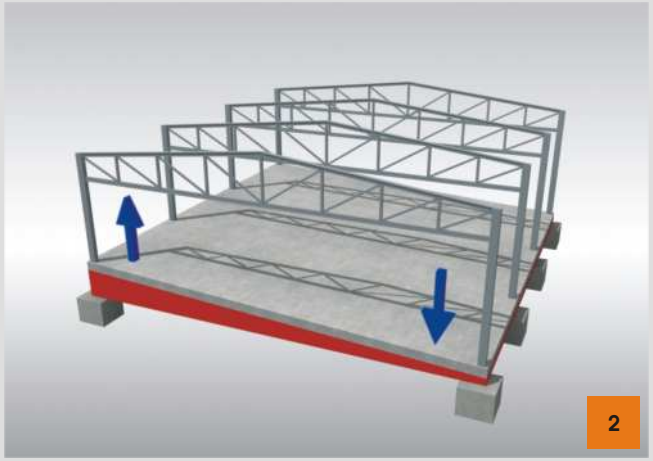
PATENTED METHOD FOR FLOOR FOUNDATION

A floor's foundation is crucial for its quality and durability. Improper technical parameters of the base construction can lead to serious problems, such as excess settlement (see pics. 1a, 1b),





differential settlement or a shifting of levels (pic. 2), which will lead to a permanent floor failure (pic. 3). The repairs or replacement of damaged floors can incur considerable extra costs.



BENDA Trade

SAMPLES OF FLOOR FAILURES

WEBFLOOR

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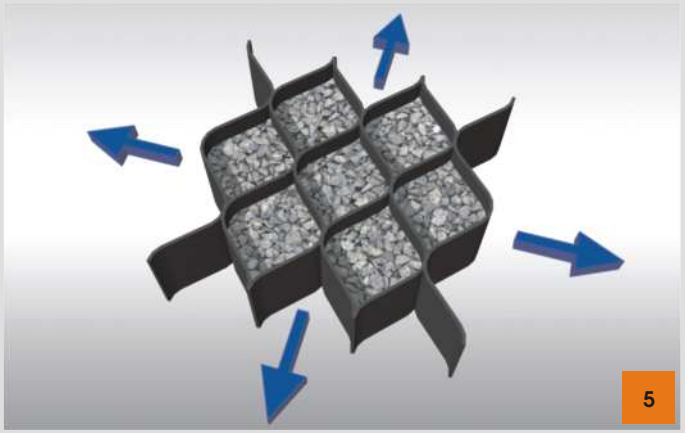
Our company BENDA TRADE s.r.o. specializes in dealing with floor foundation problems and has developed an advanced floor foundation method, called WEBFLOOR, designed for standard geological environments, as well as difficult geotechnical foundation conditions.

The effectiveness of this method has been verified through many simulation tests modeling extreme geotechnical conditions based on real constructions, in the PLAXIS software environment. When applied in the field, the results have always met with the same success.

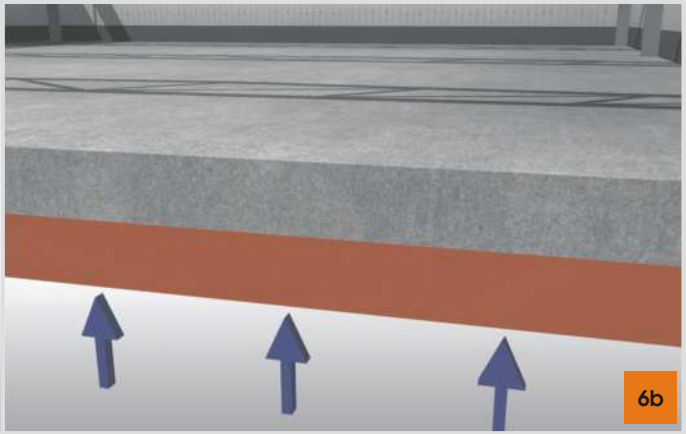
In the implementation of WEBFLOOR method, the individual maintenance and construction layers are laid horizontally on top of each other to form a sandwich-like construction (pic. 4). The main stabilization component of this construction system is the cellular confinement system – the geocell (pic. 5). Thanks to the geocell layer and its gravel filling, the whole sandwich-like construction is significantly more solid. The deformation and strength characteristics of the floor increase and the load spreads over a larger area at the same time (pics. 4, 5).


4

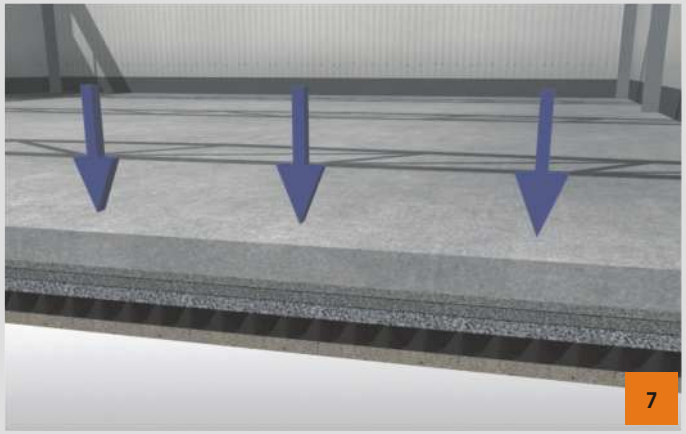

5

The main advantage of WEBFLOOR® method is the significant reduction in the thickness needed for the gravel cushion or the slab-on-grade under the floor (pics. 6a, 6b).

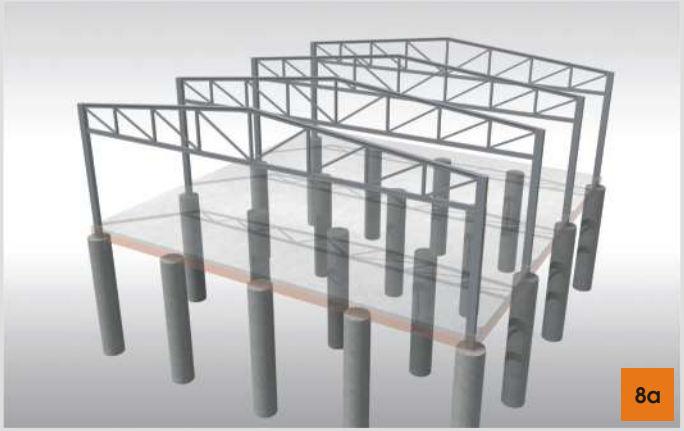

6a

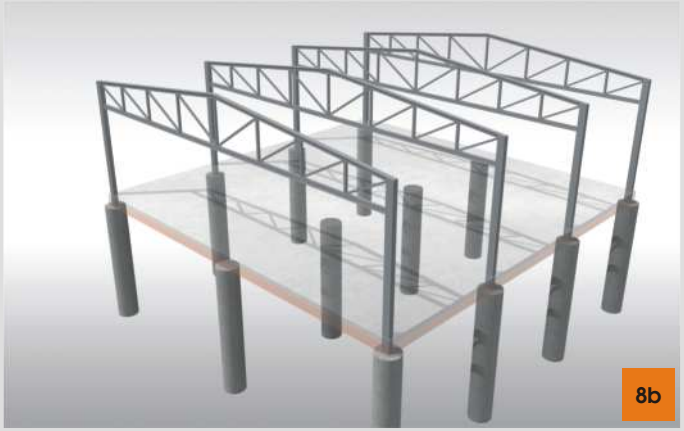

6b

WEBFLOOR® method improves the quality of the pit base, allowing a more economical construction of the concrete floor (pic. 7).

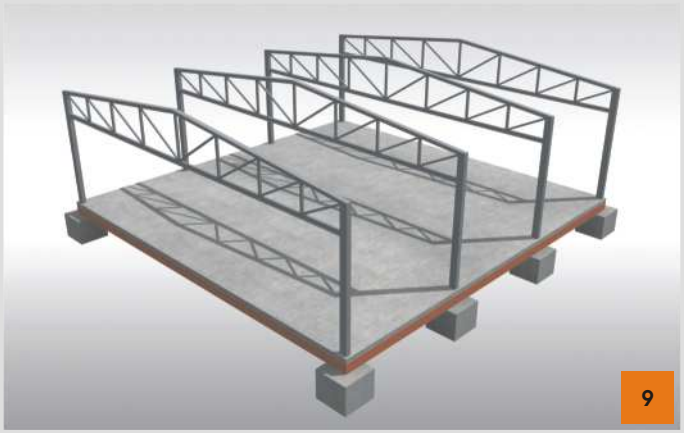

7

Thanks to its increased reliability, it is also possible to reduce the extent of the deep foundation (pics. 8a, 8b)


8a


8b

and, under certain geotechnical conditions, it is even possible to avoid installation of the deep foundation (pic. 9). It is obvious, that in addition to improving the technical parameters of the construction, these advantages produce, above all, considerable savings in construction costs.


9

WEBFLOOR® method can be widely used in the construction of floors for hypermarkets, warehouses, cold storage buildings, shopping malls, residential buildings, etc. Our company has successfully completed several major construction projects in the Czech Republic – see our projects.

In 2006, WEBFLOOR® method received subsidies from European Union funds.

WEBFLOOR® method is protected by an industrial patent and utility models valid in the Czech Republic and Slovak Republic, since 2008, in the whole of the United States of America.

USA PATENT US 7,431,536 B2

CR PATENT No: 296488

CERTIFICATE OF UTILITY MODEL REGISTRATION CR No: 13384

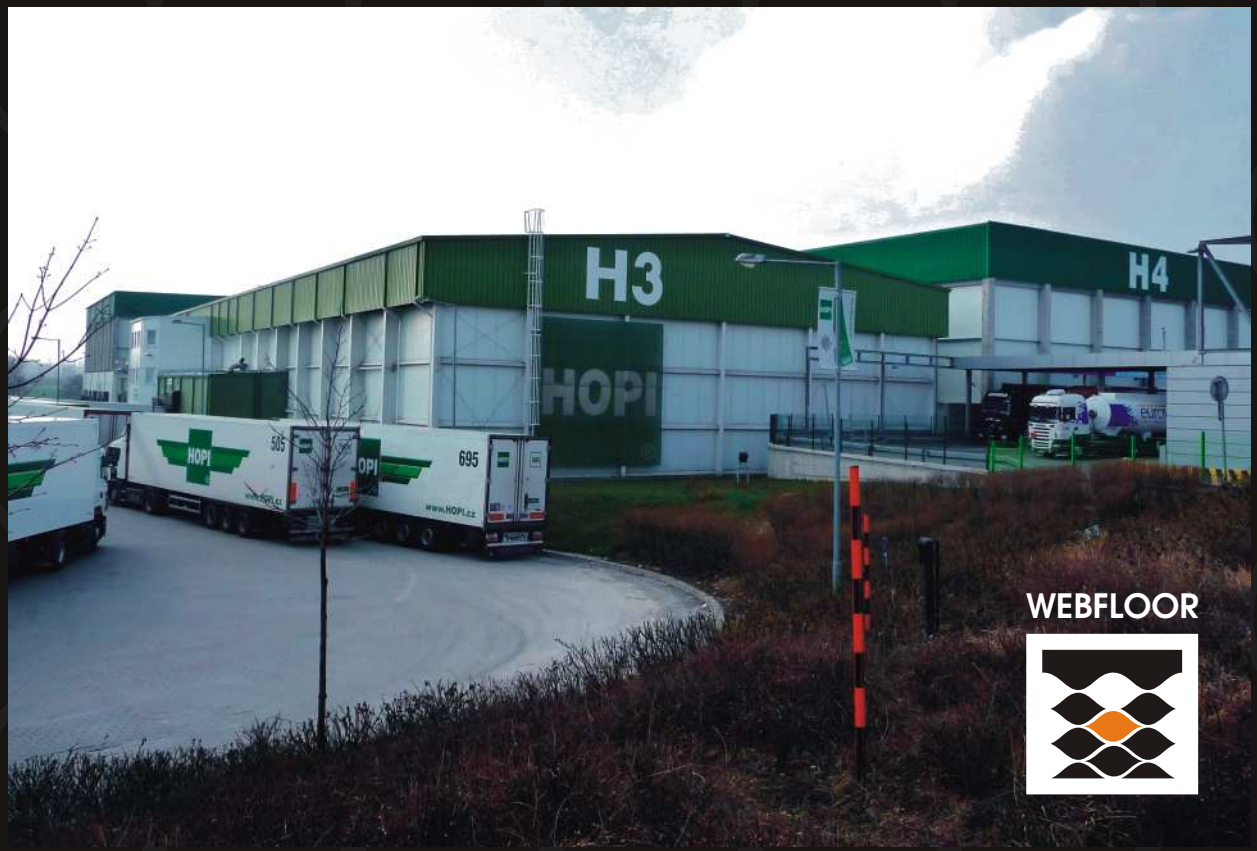
CERTIFICATE OF UTILITY MODEL REGISTRATION SR No: 3775

COLD STORAGE BUILDING

Logistic complex HOPI III Modletice

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: MARC-SA Building Systems, s.r.o.
Site: PRAHA – Modletice



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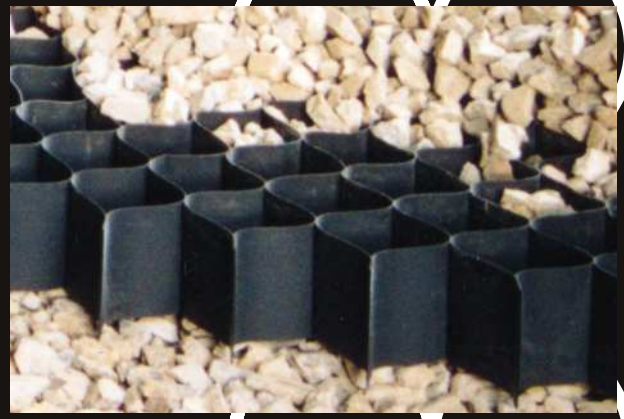
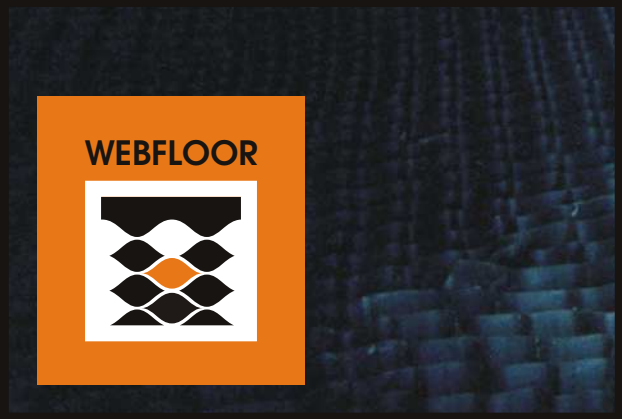
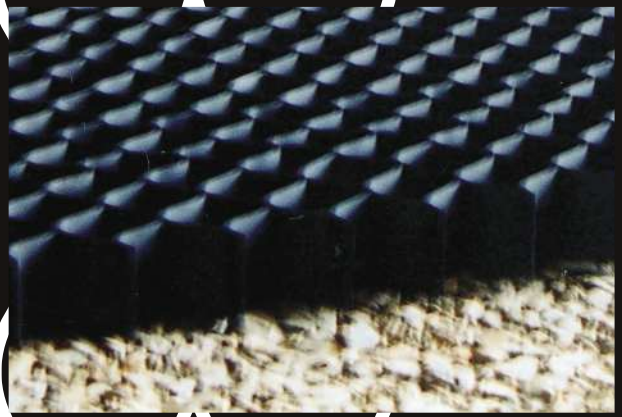
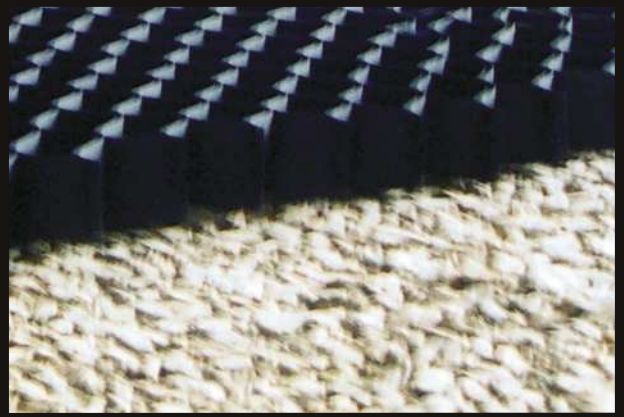




WEBFLOOR





BENDA Trade

CONSTRUCTION SPECIFICATION

Floor foundation with an application of WEBFLOOR® patented method.

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

Apart from building works, it is our standard to provide the following services:

Preparatory works:

- Detailed proposal and geotechnical assessment of reliability of the designed structure.
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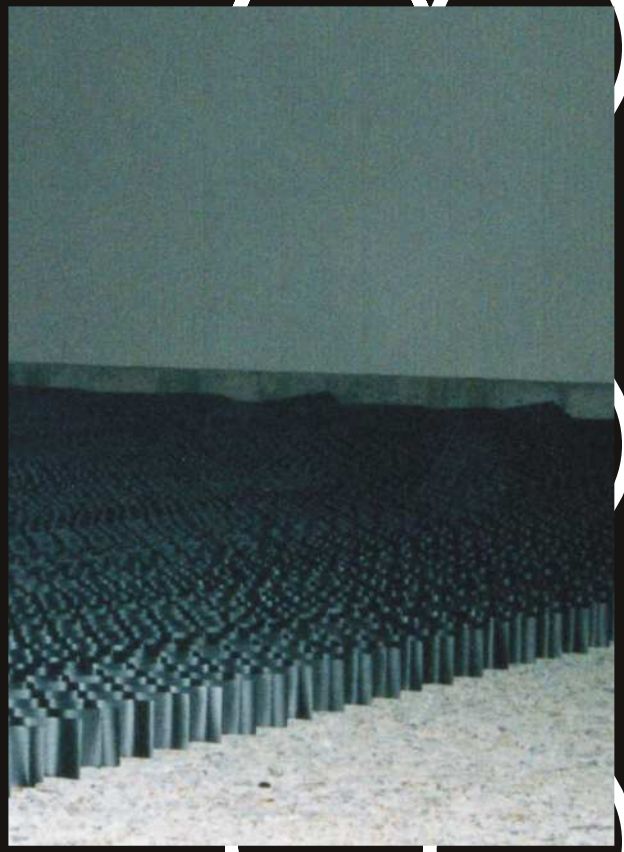
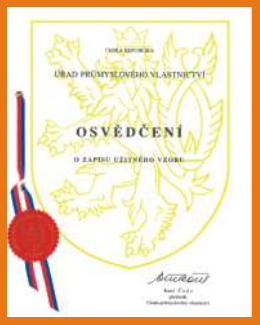


WEBFLOOR

USA PATENT US 7,431,536 B2

CR PATENT No: 296488



CERTIFICATE OF UTILITY MODEL REGISTRATION CR No: 13384

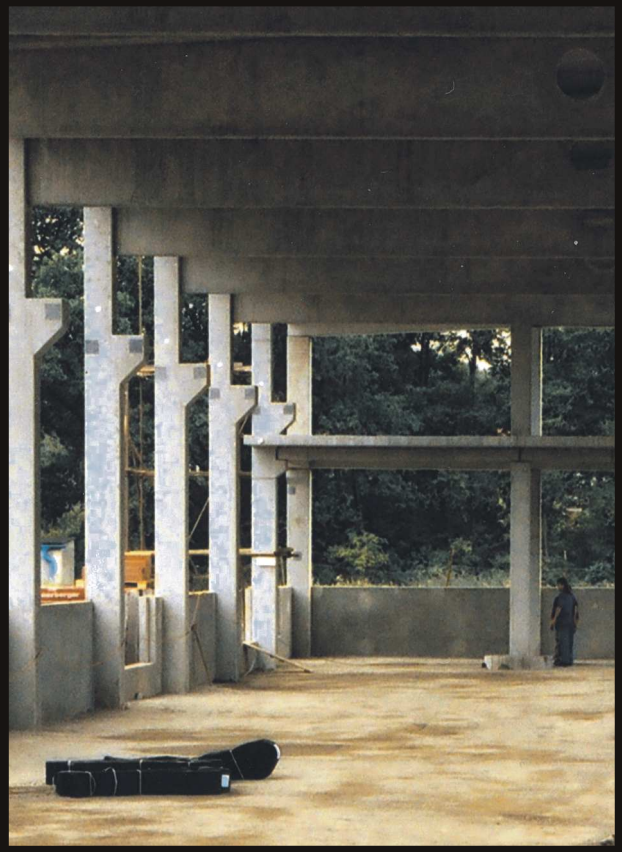
CERTIFICATE OF UTILITY MODEL REGISTRATION SR No: 3775

INDUSTRIAL BUILDING BYTOSTAV
COMPLEX NAD PORUBKOU

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: VS-INVEST a.s.
Site: Ostrava

www.benda-trade.cz




WEBFLOOR

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WEBFLOOR

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WEBFLOOR

USA PATENT US 7,431,536 B2

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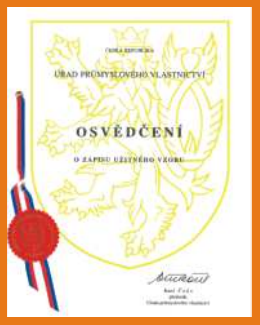

CERTIFICATE OF UTILITY MODEL REGISTRATION CR No: 13384

CERTIFICATE OF UTILITY MODEL REGISTRATION SR No: 3775

METAL PRODUCTION FACTORY
OSTRAVA – PETŘKOVICE

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: GLOMBICA Jan KOVOSERVIS
Site: Ostrava

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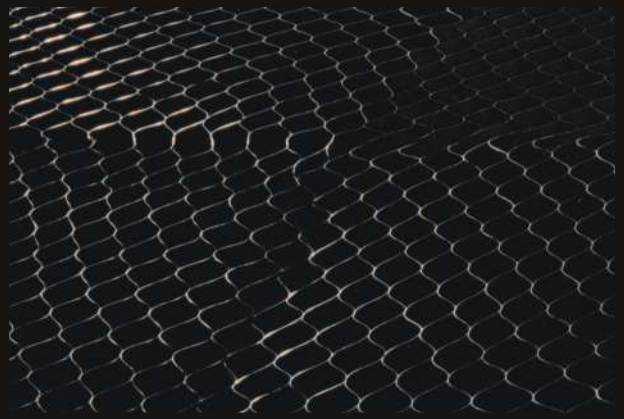
WEBFLOOR



CONSTRUCTION SPECIFICATION

Floor foundation with an application of WEBFLOOR® patented method.

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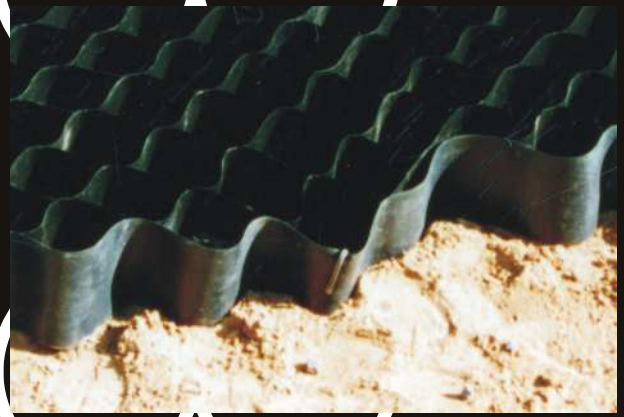

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WEBFLOOR

USA PATENT US 7,431,536 B2

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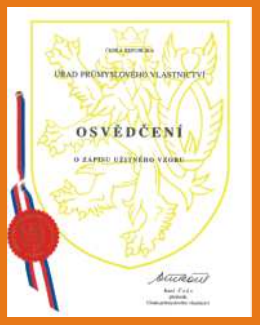

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CERTIFICATE OF UTILITY MODEL REGISTRATION SR No: 3775

INDUSTRIAL BUILDING
LAMELA CHYŠE

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Marc–SA Building Systems, s.r.o.
Site: Chyše

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WEBFLOOR

CONSTRUCTION SPECIFICATION

Floor foundation with an application of WEBFLOOR® patented method.

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

Apart from building works, it is our standard to provide the following services:

Preparatory works:

- Detailed proposal and geotechnical assessment of reliability of the designed structure.
- An unambiguously defined method for building the foundations.

Implementation phase:

- Technical supervision during the construction process.

Upon client's request, we are also able to ensure:

- Assessment of reliability of the designed construction both analytically and numerically, via simulation of the tense-deformation state by the variation finite element method.
- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.

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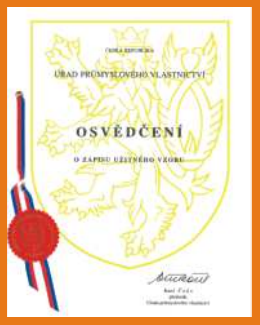
WEBFLOOR

USA PATENT US 7,431,536 B2

CR PATENT No: 296488



CERTIFICATE OF UTILITY MODEL REGISTRATION CR No: 13384

CERTIFICATE OF UTILITY MODEL REGISTRATION SR No: 3775

FLOOR FOUNDATION OF COLD STORAGE BUILDING WITH WEBFLOOR® METHOD

PURPOSE OF THE STRUCTURE, TECHNICAL DESIGN:

GEOLOGICAL COMPOSITION OF THE SUBSOIL

Resulting from the geological survey of the area in question, the subsoil loading capacity and deformation capacity related to the floor construction, the soft deluvial silty clay layers form the most important part of the floor subsoil, which also forms the active floor base-zone. Considering the fact that the low value of deformation $E_{def,2}$ = 3–5 MPa needs quite a rigid sandwich gravel cushion meeting the deformation criteria for the floor construction.

Also, the fact that the floor construction will be carried out partly in an excavation and partly on an embankment with up to 1 meter in thickness is fundamental in this case. Due to the fact that the deluvial lutaceous clay strata are thicker and less consistent in the embankment (according to the technical-geological survey – higher groundwater level in this area) large areas of higher shear strength are established in the upper parts of the embankment; for this reason in-depth consolidation of the deluvial strata was designed utilizing pre-drilled gravel-sand piles where the embankment height exceeds 40 cm.

CONSTRUCTION OF SUBSOIL DISTRIBUTION LAYERS AND THE FLOOR IN THE COLD STORAGE BUILDING

Resulting from the knowledge of the geological composition of the subsoil, as well as the need to meet the required pit base quality before placing the floor construction, the project documentation recommends the following founding method:

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Phase I – WEBFLOOR® structural layers

- Roll out a 15-cm layer of psefitic material fraction 32/63 mm
- Spread separation geotextile (weight 300 g/m^2) on the formation level
- Drainage layer of compacted psefitic material fraction 32/63 mm 25 cm thick
- Construction layer, cellular confinement system 200 mm (8 in) deep
- A dune over the cellular confinement system 200 mm (8 in) deep with gravel fill, fraction 32/63 mm, a layer 10 cm thick
- Structural gravel layer, fraction 0/63 mm, thickness 20 cm – compacted in two 10-cm plies
- Sealing layer of fraction 0/4 mm, thickness 5 cm up to the pit base

Phase II – floor construction

- Top layer: wire concrete B30, 20 cm thick
- Heat insulation JAKODUR 35/500, 20 cm thick
- B30 reinforced concrete (KARI mesh), thickness 15 cm, fitted with heating coils

The above-mentioned floor layers are positioned on the subsoil distribution layer constructed mainly using the cellular confinement system 200 mm (8 in) deep, filled in with compacted rough crushed quarry gravel, fraction 32/63 mm. The mechanical lateral grip provided by the cellular confinement system increases the stratum's hardness, as well as its parameters of strength and deformation, and helps distribute the load over the reinforcement's base. The tension strength of the geocell system also determines its partial membrane effect, thus eliminating the tensile stress resulting from different deformations of the building's subsoil.

When the subsoil and cellular confinement system 200 mm (8 in) layers have been constructed, structural loading tests shall be carried out to prove that the mandatory criterion of the minimum modulus of deformation on the pit base $E_{def,2}$ > 80 MPa and the ratio between the 2nd and the 1st loading branch n < 2.5 were met.

GEOTECHNICAL EVALUATION OF THE DESIGNED FLOOR FOUNDING METHOD

This way designed slab-on-grade floor construction, including its subsoil geological composition, the floor construction, and the resulting working load were entered into the numerical simulation model (finite elements method) using the PLAXIS 7.2 software. The evaluation and results proved that adjusting the subsoil and the structure of the distribution layer using the cellular confinement system method meet all the reliability criteria.

Reliability criteria

α – Coefficient of the form (ca 0.87 for the strip foundation)

b – Width of the loaded strip, b = 2,4 m

σ_{ol} – Contact tension, σ_{ol} = 45 kPa

υ – Poisson number, υ = 0,3

Winkler's reliability criterion

The floor will be loaded with racks of the width b = 2.4 m (length 19.6 m). A single rack section of 2.8 m length loads the floor with a total of 300 kN.

The resulting area load is as follows:

$$\sigma_d = \frac{300}{2{,}4 \cdot 2{,}8} = 45\ kPa$$

for the loading strip b = 2.4 m (width) the settling is calculated using the following formula (Gorbunov):

$$s = \frac{\sigma_{ol} \cdot \alpha \cdot b \cdot (1-\upsilon^2)}{E_{def}} \qquad k = \frac{\sigma_{ol}}{s} \qquad \text{then:} \qquad E_{def} = \frac{\sigma_{ol}}{s} \cdot \alpha \cdot b \cdot (1-\upsilon^2) \qquad \frac{\sigma_{ol}}{s} = k = \frac{E_{def}}{\alpha \cdot b \cdot (1-\upsilon^2)}$$

for E = 100 MPa (floor subsoil):

$$k = \frac{100}{0{,}87 \cdot 2{,}4 \cdot (1-0{,}3^2)} = 52{,}6\ \text{MN/m}^3 = 0{,}052\ \text{N/mm}^3 > 0{,}003$$

The required criterion of the minimal value of the proportion of the strain resistance (coefficient of the loading capacity) should not exceed the range k = 0.003 – 0.07 N/mm3. The requirement was met.

Subsoil load-bearing capacity criterion

Strip width: b = **2,4 m**

Embankment layers total height: **1,3 m**

Distribution angle: α = **63°**

Total loading width:

$$b` = 2{,}4 + 2 \cdot \frac{1{,}3}{tg60°} = 3{,}9\ \text{m}$$

Contact tension:

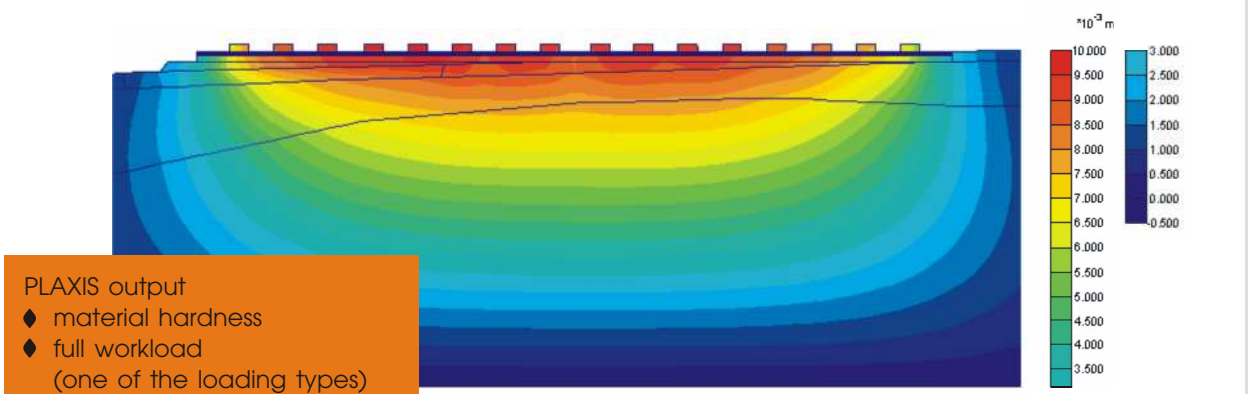
$$\sigma_{ol} = \frac{45 \cdot 2{,}4}{3{,}9 \cdot 1} = 27{,}7\ \text{kPa} < R_{tt} = 50\ \text{kPa}$$

The subsoil loading capacity conforms to the criteria.

Settlement and inclination criteria

A numeric model (finite elements method) using the PLAXIS 7.2 software was used to determine the settlement and inclination criteria for the rack structures as well as the overall interaction between the floor and its subbase. The model considered all loading types and resulted in the following statements:

- The maximum allowed inclination criterion i_{max} = 0.001 was not exceeded for any loading type
- The maximum floor settlement is approx 12 mm
- The transition between piled and non-piled subsoil causes no changes in the differential settlement, the settlement curve being even
- The maximum loading of the clayey subsoil does not exceed R_{dt} = 50 kPa. None of these loading types damages the subsoil by shear
- The maximum value of the direct stress in the reinforced concrete floor construction is approximately 130 kPa; the strain is always the compression



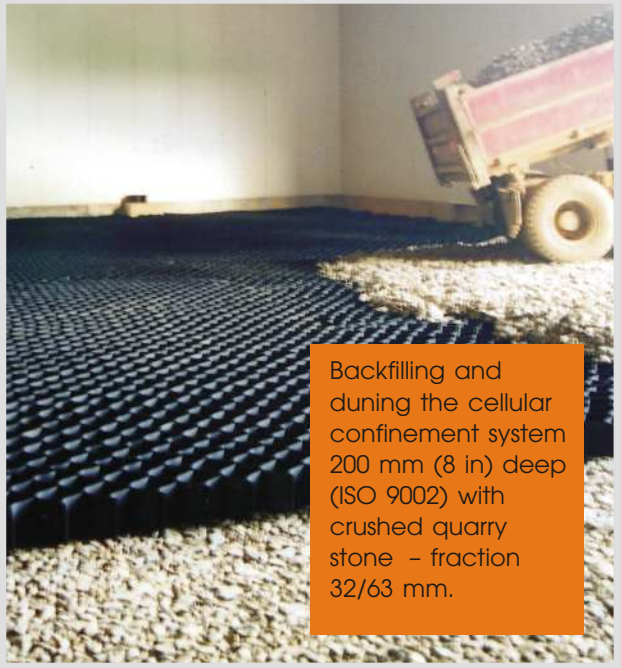
PLAXIS output
- material hardness
- full workload
  (one of the loading types)

The evaluation and results of the mathematical simulation model prove that the designed structure used for the modification of the subsoil and the structure of the distribution layer using the cellular confinement system method meets all the necessary reliability criteria. Based on the results of the model and authors' views, the structural engineer included the full gravel cushion in the project documentation.

BRIEF SPECIFICATION OF THE CONSTRUCTION:

The slab-on-grade was carried out as per the project documentation, where the so-called drainage layer 250 mm thick was spread over the rehabilitated pit base consisting of crushed quarry aggregate of fraction 32/63 mm, vibration-compacted. The drainage layer is covered by the cellular confinement system 200 mm (8 in) deep, then backfilled by crushed quarry stone fraction 32/63, incl. a 100-mm dune of crushed quarry aggregate of the same fraction, all carried out by employees of BENDA TRADE s. r.o. The layer above the cellular confinement system is static-compacted.

Laying and joining of strips of the cellular confinement system 200 mm deep (ISO 9002) done by BENDA TRADE s.r.o.



Backfilling and duning the cellular confinement system 200 mm (8 in) deep (ISO 9002) with crushed quarry stone – fraction 32/63 mm.

The precision of laying the cellular confinement system 200 mm (8 in) deep was proven by a very low value of the ´n´ ratio between the 2nd and the 1st loading branch, providing substantially higher quality of the padding after covering the foundation with the upper structural layer.

The cellular confinement system 200 mm (8 in) layer is covered with the upper structural layer of the crushed quarry gravel cushion – fraction 0/63 mm in two isolated layers, each 100 mm thick, with the overall thickness of 200 mm. The quality of the gravel foundation cushion was tested by both static and dynamic loading all over the hall area and meets the requested criteria. $\mathbf{E_{def,2} > 80\ MPa,\ n < 2,5}$.

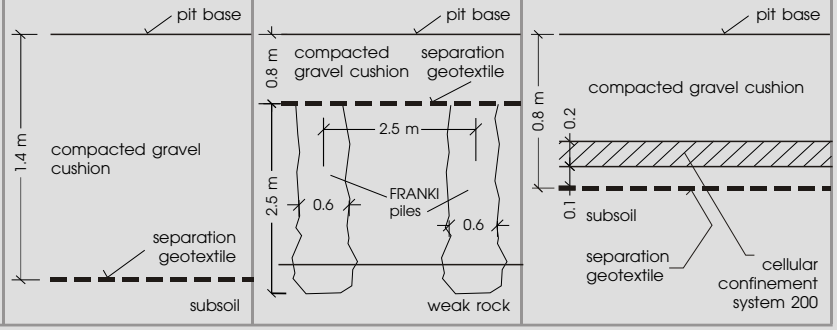
The achieved static load tests resulted in values of the modulus of deformation ranging from **$E_{def,2}$ = 103,5 – 138,4 MPa**, substantially exceeding the values stated by the structural engineer. The ratio between the 2nd and the 1st loading branch ranges between **n = 1.96 – 2.6.**

For small differences between the moduli of deformation E measured during the static load tests $E_{def,2}$ may be stated that the cushion structure may be regarded as **homogenous with the minimum difference in quality throughout the building**. The achieved results fully **meet and even exceed** the requirements on the quality of the pit base for founding a floor construction of a cold storage building.

Rolling the psefitic material into the cellular confinement system 200 mm (8 in) deep (ISO 9002) (using a static roller VV 200)

In conclusion, an overall geo-technical evaluation is recommended when founding complex buildings, especially on geologically complicated sites (according to ČSN 731001 3rd geo-technical categories). The geo-technical evaluation must be carried out within the design, as happened in the above-mentioned case, where the herein presented founding method was used for building a flat, reinforced gravel cushion based on the design, the numeric model of the finite elements, and structural calculations implementing the WEBFLOOR® method technology which fully met and, in terms of quality, even exceeded the required criteria.

METHODS OF FLOOR FOUNDATION IN HOPI III COLD STORAGE BUILDING

Type of structure	Gravel cushion	FRANKI piles	WEBFLOOR® method	Advantages of WEBFLOOR® foundation method
Method of foundation	*slab-on-grade*	*deep foundation*	*slab-on-grade*	
Type of structure	sandwich-like compacted psetific material	pre-drilled gravel cushions + gravel cushion (less thick)	sandwich-like psetific layers mechanically confined with WEBFLOOR®	
Depth of structure	**1.3 – 1.5 m**	**Franki piles** ♦ **depth 2.5 m** **gravel cushion** ♦ **depth 0.8 – 1.0 m**	**0.8 m**	less thick construction
Demands on building works	high demands on method of laying and compaction to achieve requirement as per PD	♦ two technological procedures ♦ demanding on machine equipment ♦ time consuming	♦ cellular confinement system 0.2 m placed ♦ gravel dune 0.6 m thick constructed	♦ easy placing ♦ lower demands on thickness of compacted dune layers
Compliance with technical requirements	unwanted differential settlement, problem to achieve desired $E_{def,2}$ and $E_{def,2}/E_{def,1}$ as per PD	Franki piles - only consolidate and stabilize subbase ♦ spread gravel cushion meeting PD requirements must be installed	♦ no excessive differential settlement ♦ safety requirements of floor met as per PD ♦ required parameters of strength of pit base exceeded by approx. 50 - 70%	all requirements of floor's safety met requirements as per PD significantly exceeded: as per PD $E_{def,2}$ = 80 MPa achieved: $E_{def,2}$ = 110 - 140 MPa
Balance sheet (cost share in %)	**61%**	**100 %**	**51%**	by 10% lower costs than with gravel cushion by 49% lower costs than with deep foundation
Diagrammatic drawing of construction				

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Mobile: 00420 777 743 991
benda@benda-trade.cz

www.benda-trade.cz

BENDA Trade

OUR PROJECTS

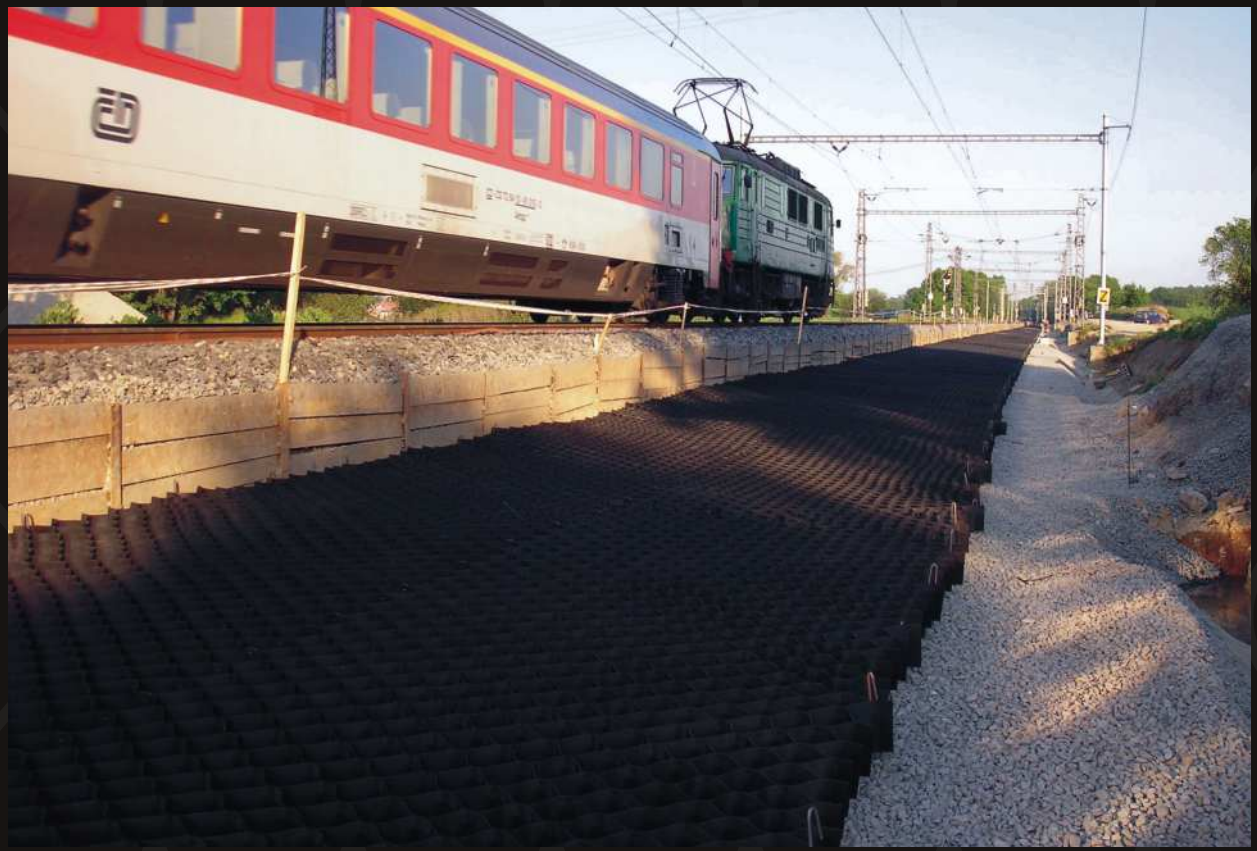
SUBBASE CONFINEMENT

CZECH RAILWAYS

Reconstruction of a railway roadbed
Railway station Petrovice u Karviné – state border, rail track no. 1 and 2

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: UNIGEO a.s.
Site: Railway station Petrovice u Karviné – state border



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PHASE 1

CONSTRUCTION SPECIFICATION

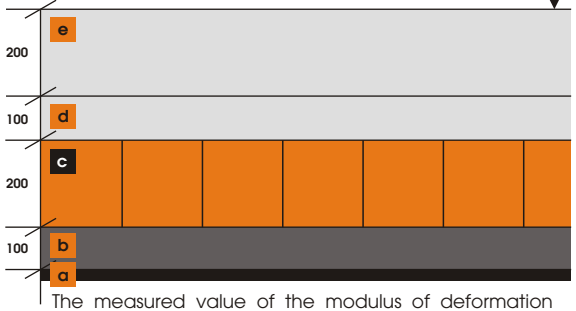
The railway roadbed was designed as redeveloped and rehabilitated on the railway fill according to SŽDC (Railway Infrastructure Administration) S4, Annex 6, point 9.C, TYP3 using the cellular confinement system – CCS (geocell) 200 mm (8 in) deep. Within approximately one third of the track the CCS system was combined with the method using consolidation gravel pads.

GEOTECHNICAL SURVEY

Positions of cohesive materials of soft consistence were checked in the natural ground and the embankment. The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 4 - 6 MPa**.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 62 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{or} = 4 - 6 MPa**.

a) Separation geotextile 300 g/m^2.
b) Drainage gravel layer, fraction 16 – 32 tl. 100 mm.
c) Cellular confinement system (geocell), strip width 4,80 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.

PHASE 2

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

PThe average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 62 MPa**.

REGULATIONS SŽDC


SŽDC

OSVĚDČENÍ

č. 193/2008-OP

o kvalitě

splňují

According to the regulation on SŽDC S4, Appendix no. 4 for the main national railway tracks, for speed 120 – 160 km (during reconstruction) with minimum requirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: **E_{pl} = 50 Mpa**.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

PHASE 2

BENDA Trade

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

Apart from building works, it is our standard to provide the following services:

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Implementation phase:

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- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.

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UNIGEO a.s.
Polní geotechnická laboratoř, akreditovaná laboratoř ČIA, č.1412.2
Místecká 329/258
720 00 Ostrava - Hrabová

Číslo zkoušky : ZZ 2

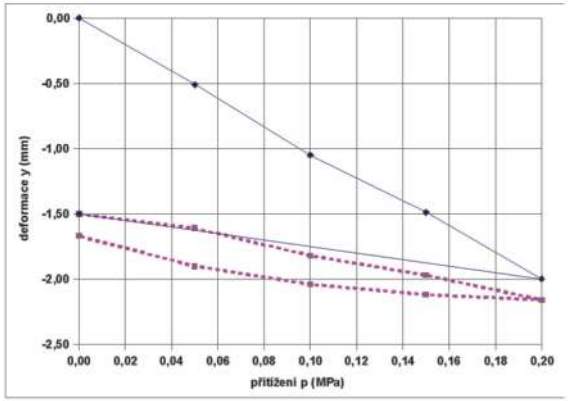
Název zakázky : Rekosntrukce žel. spodku v km 291,750 - 292,540

Číslo zakázky : Z 507113

Název a adresa zákazníka :
UNIGEO a.s. SANEKO
Místecká 329/258, 720 00 Ostrava - Hrabová

Metoda : Statická zatěžovací zkouška podloží a podkladních vrstev vozovek (ČSN 73 6190), MPPZ 103

Protokol statické zatěžovací zkoušky podloží a podkladních vrstev vozovek



Modul přetvárnosti	E_{def} [MPa]=	68,18
Maximální celková svislá deformace v 2.cyklu	y [m] =	0,00066

Vypracoval : ing.Skopal Schválil : ing. Skopal

MĚŘENÍ STATICKÉHO MODULU PŘETVÁRNOSTI

Akce:	Rekosntrukce žel. spodku v km 291,750 - 292,540	Místo:	
Č.úkolu:	Z 507113	Staničení :	km 292,324
Č. zk. :	ZZ 2	Kolej :	
Počasí :	polojasno 4,0 C°	Datum zkoušky :	6.11.2007
Poloha zatěžovací desky :	výšková úroveň - 400 mm nad buněčným zpevňovacím materiálem		
Hloubka uložení zatěžovací desky :	terén	Měření provedl :	ing.Skopal
Zatěžovací zkouška provedena na :	kamenivo drn. GP, frakce 0-32		
Podloží zatěžované vrstvy :	od hloubky 0,4 m buněčný zpevňovací materiál výšky 200 mm		
Poznámky :			

Zatěžovací deska d=0,30 m F= 707 cm2

Tlak zatěžovací desky na zeminu MPa	Sedání desky mm	
0,00	0,00	
0,05	0,51	
0,10	1,05	
0,15	1,49	
0,20	2,00	◄------
0,00	1,50	◄------
0,05	1,61	
0,10	1,82	
0,15	1,97	
0,20	2,16	◄------
0,15	2,12	
0,10	2,04	
0,05	1,90	
0,00	1,67	

E_{def} = 68,18 MPa

E_{def}=1.5*p*r/y y= 0,00066 m

E2/E1= 3,030

Pozn. "r" ... poloměr zatěžovací desky

Nejistoty měření:

Nejistota měření modulu přetvárnosti je Edef ± 6,0 MPa a je součinitelem rozšířené standardní nejistoty měření a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí asi 95%.

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Reconstruction of the railway fill of the roadbed
Chomutov – Cheb railway track

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Viamont a.s.
Site: Chomutov – Cheb

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CONSTRUCTION SPECIFICATION

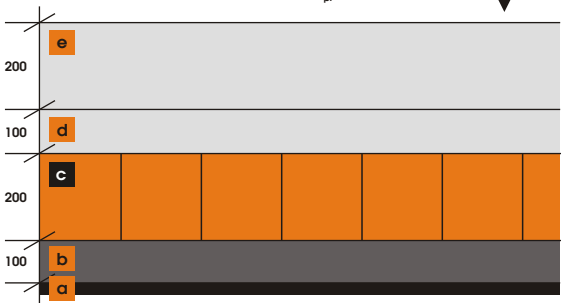
The railway roadbed was designed as redeveloped and rehabilitated on the railway fill according to SŽDC (Railway Infrastructure Administration) S4, Annex 6, point 9.C, TYP3 using the cellular confinement system – CCS (geocell) 200 mm (8 in) deep.

GEOTECHNICAL SURVEY

Positions of cohesive materials of soft to locally pasty consistence were checked in the natural ground under the embankment, in the cutting, and in the roadbed embankment. The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 2–4 MPa**.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 51 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 2–4 MPa**.

a) Separation geotextile 300 g/m^2.
b) Drainage gravel layer, fraction 16 – 32, 100 mm thick.
c) Cellular confinement system (geocell), strip width 4,80 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 51 MPa**.

REGULATIONS SŽDC

According to the regulation on SŽDC S4, Appendix no. 4 for the other national railway tracks, for speed limit 120 km (during reconstruction) with minimum requirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: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E_{pl} = 40 MPa.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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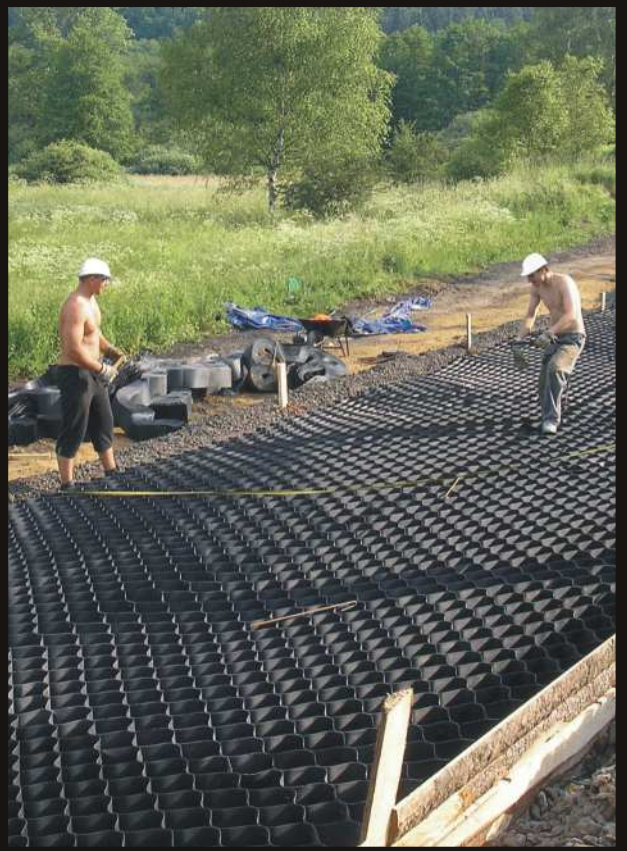

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TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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- An unambiguously defined method for building the foundations.

Implementation phase:

- Technical supervision during the construction process.

Upon client's request, we are also able to ensure:

- Assessment of reliability of the designed construction both analytically and numerically, via simulation of the tense-deformation state by the variation finite element method.
- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.

Reconstruction of a railway crossing
Podbořany

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Chládek & Tintěra a.s.
Site: Podbořany

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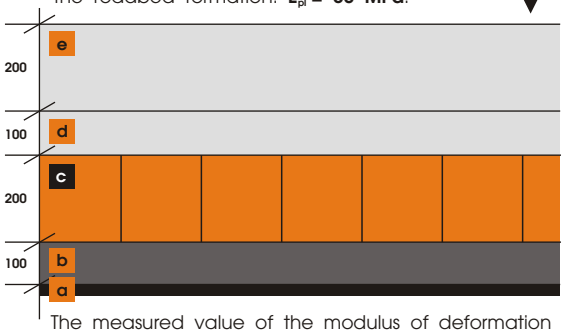
GEOTECHNICAL SURVEY

Cohesive soil. The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 23,3 MPa**.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 83 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 23,3 MPa.**

a) Separation geotextile 350 g/m^2.
b) Drainage gravel layer, fraction 16 – 32, 100 mm thick.
c) Cellular confinement system (geocell), strip width 5 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 83 MPa**.

REGULATIONS SŽDC


SŽDC

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o kvalitě
bandážního zpevňovacího materiálu
splňují

According to the regulation SŽDC S4, Appendix no. 4 for the other national railway tracks with speed limit 120 km, the minimum requirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: **E_{pl} = 80 MPa**.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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Implementation phase:

- Technical supervision during the construction process.

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- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.

Czech Railways (Ceske drahy), Rehabilitation of railway embankment slide

Railway track No. 1 Chomutov – Cheb

BENDA Trade

Contractor:	BENDA TRADE s.r.o.
Client:	UNIGEO a.s.
Site:	Railway track No. 1 Chomutov – Cheb
Contractor of the project:	UNIGEO a.s.

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CONSTRUCTION SPECIFICATION

Based on a complex analysis, rehabilitation was designed on the railway fill of Chomutov-Cheb track. In the construction, gravel pads, subhorizontal nails and the reinforced earth slab were combined with the cellular confinement system (geocell).

CHARACTERISTICS OF THE AREA IN QUESTION

The two-track electrified railroad in the planned segment of the slope failure runs on the embankment approximately 12 – 12.2 m high. The total track lowering of the track grid of the track no. 1 from the original level reached down to 1.1 m now.

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RAILWAY EMBANKMENT: REHABILITATION AND STABILISATION PROJECT

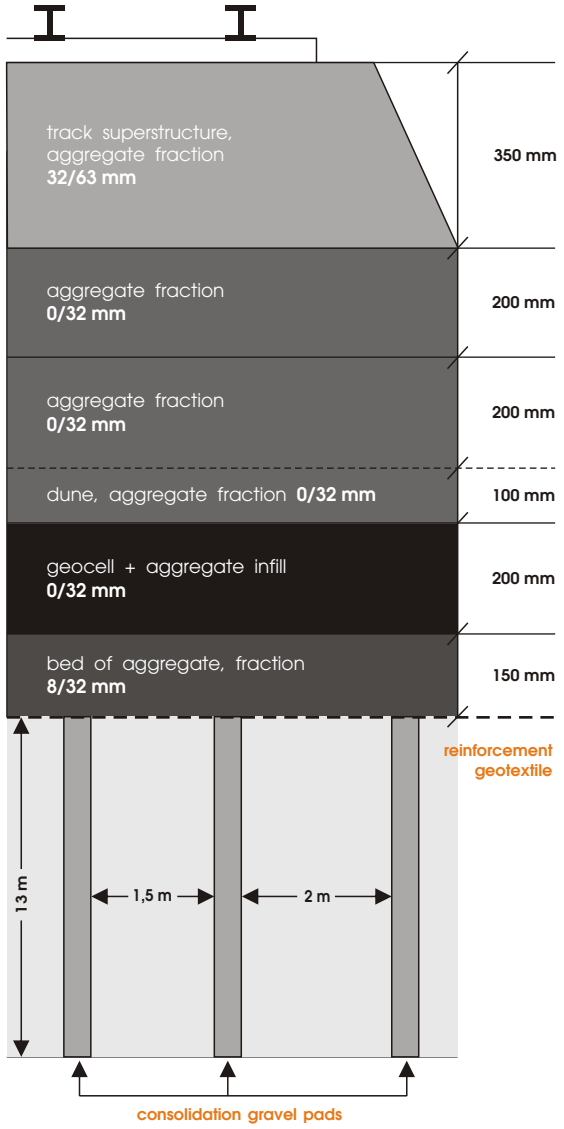
Referring to the results of the geotechnical survey and repeated investigation of the area in question, the rehabilitation was divided into the following sections:

- Surface drainage, mending of the culvert, and organization of the surface water.
- Consolidating compaction of the embankment by gravel pads.
- Stabilization of the tie bed and the embankment's slope by TITAN nails.
- Rehabilitation and reconstruction of the roadbed by cellular confinement system (geocell).

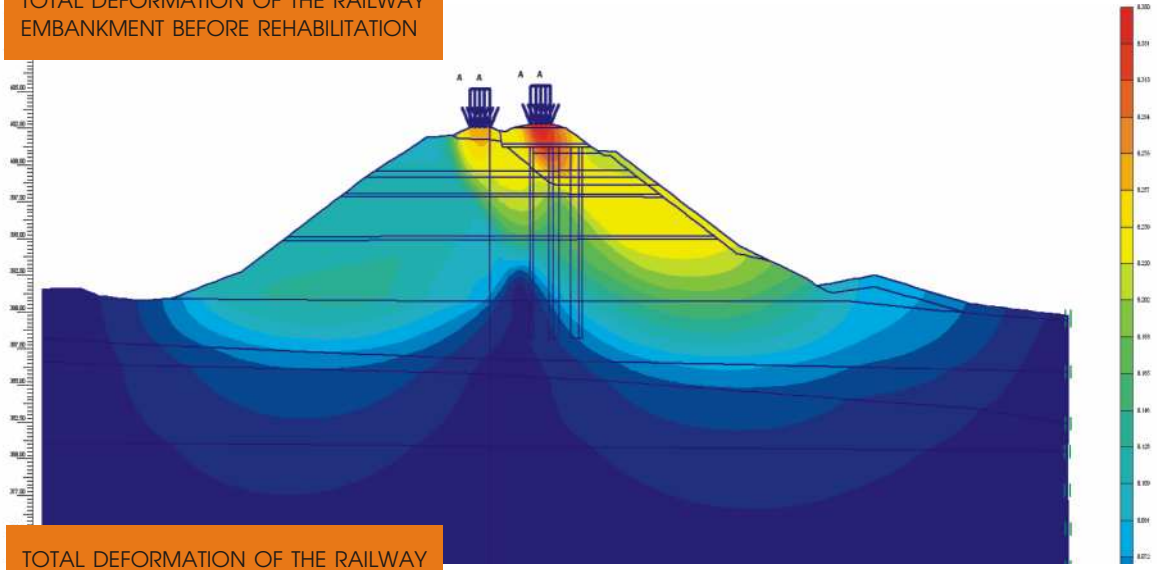
MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- **By building the reinforced loading plate the strain from loading imposed by train units was substantially reduced. The mechanical effect of the side confinement of the infill of the cellular bracing material (geocell) substantially increased rigidity of the layer, its qualities in respect of deformation and strength, and contributed to an even distribution of loading over a larger area while eliminating the excessive values of differential deformations (differentiation of levels) on the track-grid line.**
- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = rehabilitation of 250 m railway track
- Manual placing without using machinery.

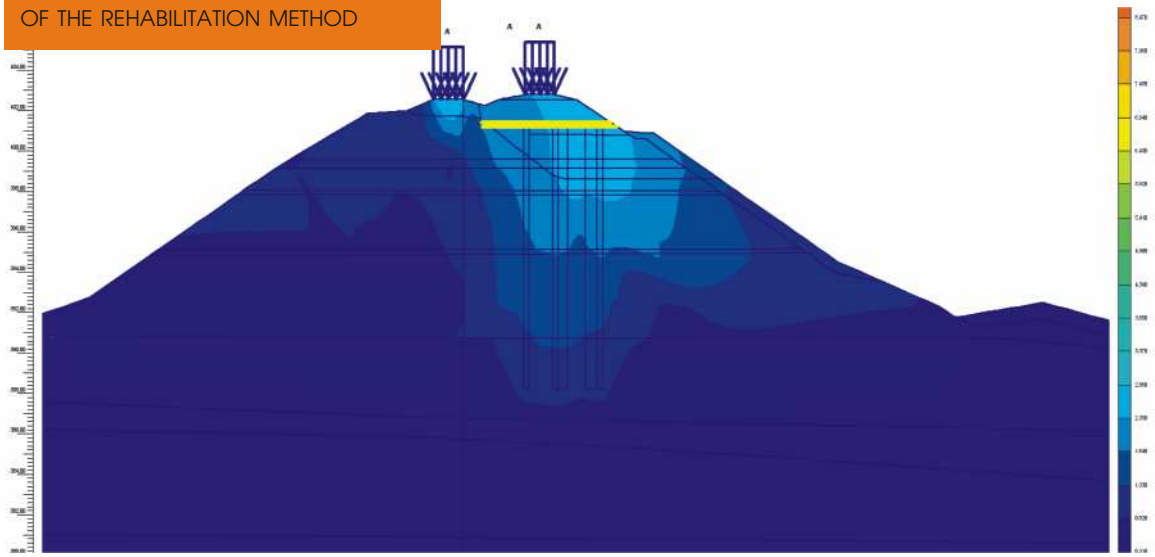
REINFORCED LOADING PLATE



TOTAL DEFORMATION OF THE RAILWAY EMBANKMENT BEFORE REHABILITATION



TOTAL DEFORMATION OF THE RAILWAY EMBANKMENT AFTER IMPLEMENTATION OF THE REHABILITATION METHOD



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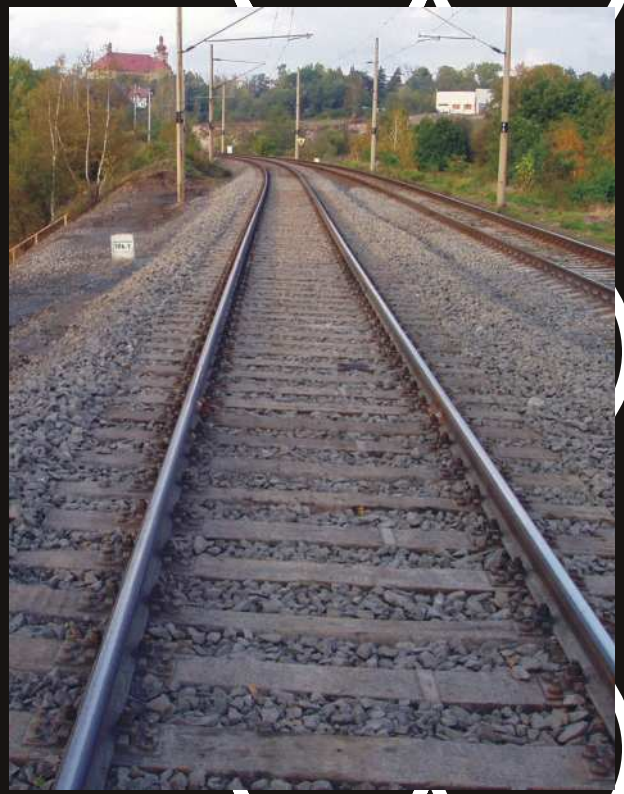

Czech Railways
– optimization of railway
ČD Skalice – Česká Třebová

BENDA Trade

Site: Skalice – Česká Třebová

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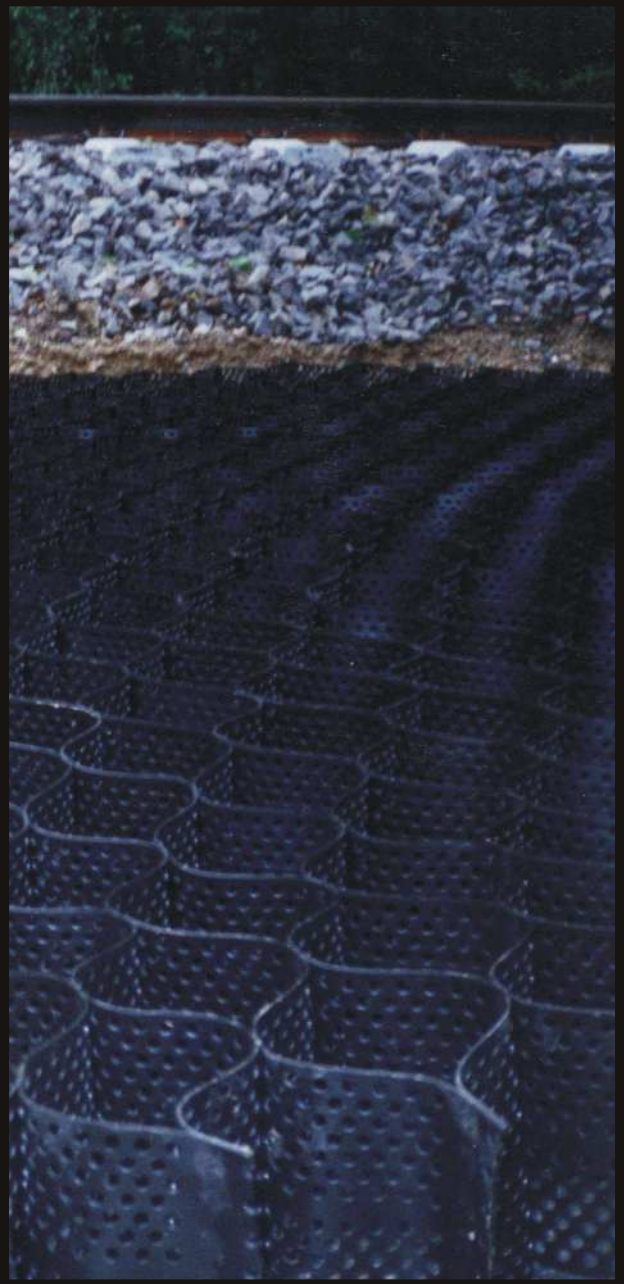

CONSTRUCTION SPECIFICATION

Reconstruction of a railway embankment:

a) Stabilization and consolidation of the formation of poor load-bearing capacity

b) Stabilization of segments affected by slope deformations

The railway embankment was reconstructed using the cellular confinement system (geocell), cell depth 200 mm (8 in).

GEOTECHNICAL SURVEY

a) Insufficient rigidity of the base (formation).

b) Instability of the slopes in segments 239,08 – 239,2 and 239,86 – 239,91 km.

c) Depression over the grade ("water sacks") – stationing 239,110 – 239,200 and 239,860 – 239,900 (track 1).

d) The divide between the gravel bed strata and clayey formation soils is 0.8 – 1 m deep below the tie's top edge.

e) However, inhomogenities in the deeper subsoil strata of unclear interpretation may relate to the change of dampness, consistence, etc.

f) The clayey subbase consists of saturated soils of semi-rigid to soft consistence. The depth of these soils (thickness) is 0.6 – 1.4 m according to the penetration surveys.

g) The modulus of deformation of the formation – 4 MPa (due to the results of dynamic penetration this value may drop as low as 3 MPa).

h) The number of direct tests of mechanical properties is very low. The results of penetration surveys are more valuable, confirming the herein above-mentioned conclusions.

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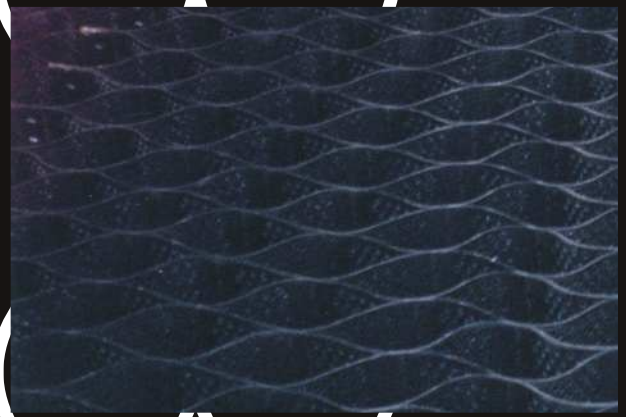

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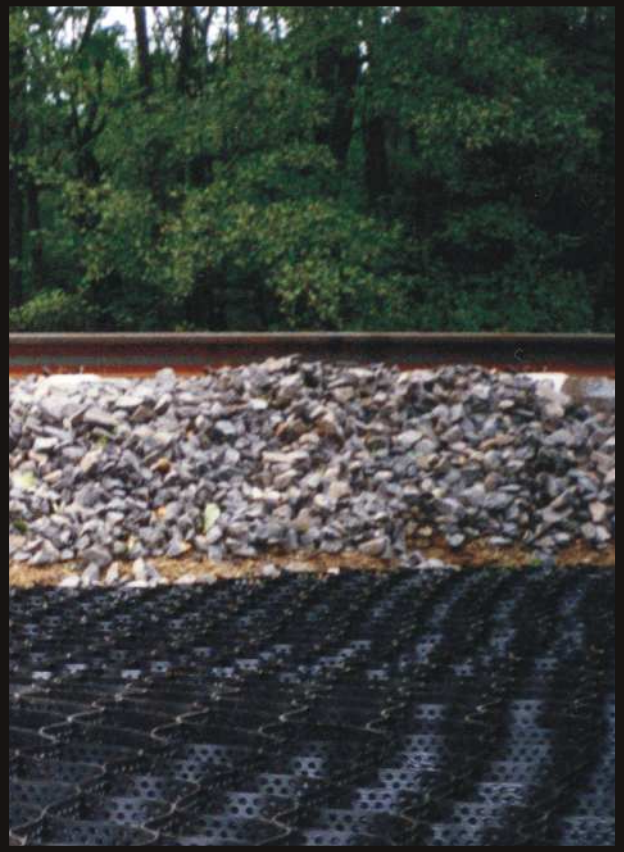

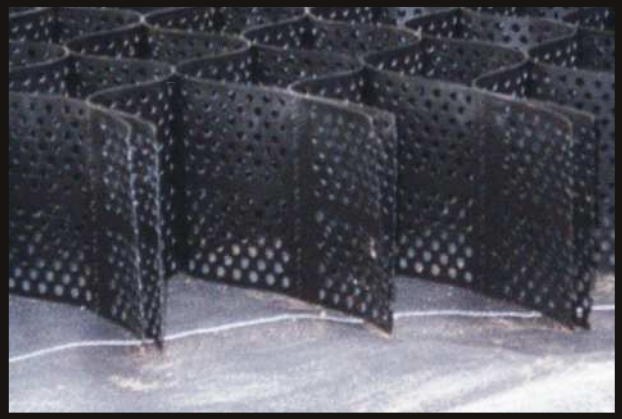

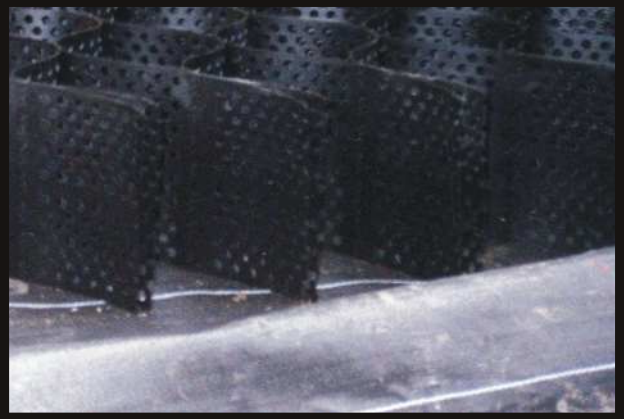

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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Reconstruction of a railway roadbed
Býlnice – Horní Lideč

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: UNIGEO a.s.
Site: Býlnice – Horní Lideč

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CONSTRUCTION SPECIFICATION

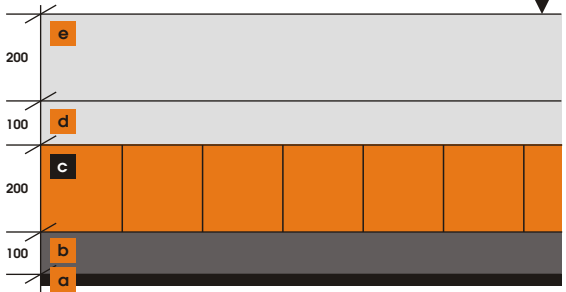
The railway roadbed was designed as redeveloped and rehabilitated on the railway fill according to SŽDC (Railway Infrastructure Administration) S4, Annex 6, point 9.C, TYP3 using the cellular confinement system – CCS (geocell) 200 mm (8 in) deep.

GEOTECHNICAL SURVEY

Positions of cohesive materials of soft to locally pasty consistence were checked in the natural ground and the embankment. The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 3 – 5 MPa**.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 60 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 3 – 5 MPa**.

a) Separation geotextile 300 g/m^2.
b) Drainage gravel layer, fraction 16 – 32, 100 mm thick.
c) Cellular confinement system (geocell), strip width 4,80 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 60 MPa**.

REGULATIONS SŽDC

According to the regulation SŽDC S4, Appendix no. 4 for the other national railway tracks with speed limit 120 km, the minimum equirement on the load-bearing capacity and the compaction rate of the road-bed – modulus of deformation – of the roadbed formation: **E_{pl} = 40 MPa**.

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Společnost (firma): BENDA TRADE s. r. o.
se sídlem: Karolinská 291/25
110 00 Praha 1 – Staré Město

Platnost „Osvědčení" je stanovena do 28. 2. 2011

V Praze dne 12. 2. 2008

Ing. Radovan Kovařík
Ředitel odboru provozuschopnosti ZDC

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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- Supervision performed by a geo-technical engineer who will check civil engineering and erection work.

Reconstruction of the railway crossing
České Budějovice

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: EDIKT a.s.
Site: České Budějovice

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MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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BENDA Trade


EDIKT
GEHL

Reconstruction of railway track No. 1
Ústí nad Labem Střekov – Boletice

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: UNIGEO a.s.
Site: Ústí nad Labem Střekov – Boletice

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CONSTRUCTION SPECIFICATION

The two-track electrified railroad on an embankment approximately 9 m high.

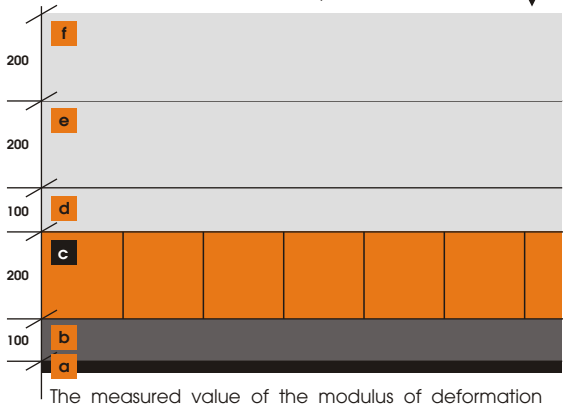
GEOTECHNICAL SURVEY

Cohesive soils of soft to locally pasty consistence are present both in the embankment and in the roadbed. Geological strata are highly saturated at the embankment's foot. After excavation, the E-value of the formation was measured as:

E_{0r} = 1-3 MPa.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 70 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 1-3 MPa**.

a) Separation geotextile 300 g/m^2.

b) Drainage gravel layer, fraction 16 – 32, 100 mm thick.

c) Cellular confinement system (geocell), strip width 4,80 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.

d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.

e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 70 MPa**.

REGULATIONS SŽDC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According to the regulation SŽDC S4, Appendix no. 4 for the main national railway tracks, for speed 120 - 160 km (during reconstruction) with minimum requirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: **E_{pl} = 50 MPa**.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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Reconstruction of the railway crossing on the track Chomutov – Cheb

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Chládek & Tintěra a.s.

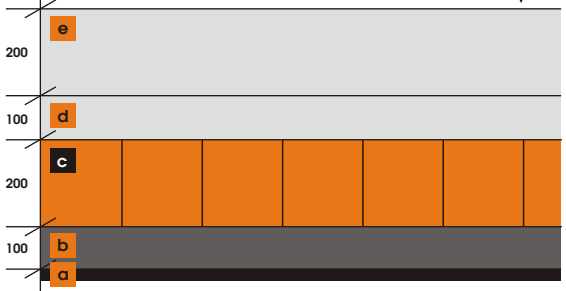
www.benda-trade.cz

GEOTECHNICAL SURVEY

Cohesive soils. The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 17 MPa**.

REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 84 MPa**.



The measured value of the modulus of deformation of the formation after excavation: **E_{0r} = 17 MPa**.

a) Separation geotextile 350 g/m^2.
b) Drainage gravel layer, fraction 16 – 32, 100 mm thick.
c) Cellular confinement system (geocell), strip width 5 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
d) Dune over CCS 100 mm, gravel fr. 0 – 32 mm.
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.

RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 84 MPa**.

REGULATIONS SŽDC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According to the regulation SŽDC S4, Appendix no. 4 for the other national railway tracks with speed limit 120 km, the minimum equirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: **E_{pl} = 80 MPa**.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day = 250 m of the railway track.
- Manual placing without using machinery.

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ČD (Czech Railways), Optimization of the railway track Ostrava – Petrovice

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: TCHAS spol s r.o.
Site: Ostrava – Petrovice

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GEOTECHNICAL SURVEY

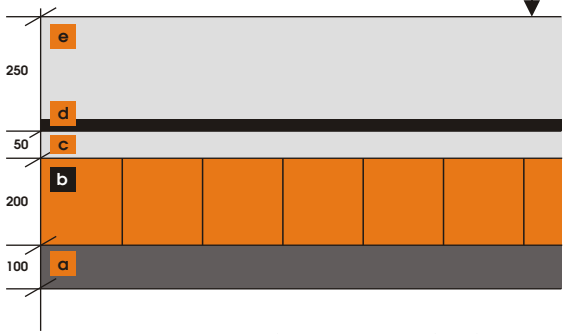
The results of geotechnical survey showed soils of soft to semisolid consistence. According to the granulometric curve, the soils in the ground are dangerously vulnerable to frosting. The hydrologic regime of the tie bed is adverse. The reduced modulus of deformation was discovered by structural load-bearing tests: E_{0r} **= 4 MPa**.

CONSTRUCTION SPECIFICATION

In the scope of optimization work to the Ostrava – Petrovice u Karviné corridor track, the roadbed was rehabilitated of the track no. 2 between Dětmarovice and Petrovice u Karviné where the grade was of an extremely low load-bearing capacity. The ground was rehabilitated using the cellular confinement system (geocell). This railway track section runs in a cutting, the plain consists of saturated high-plasticity clayey soil.

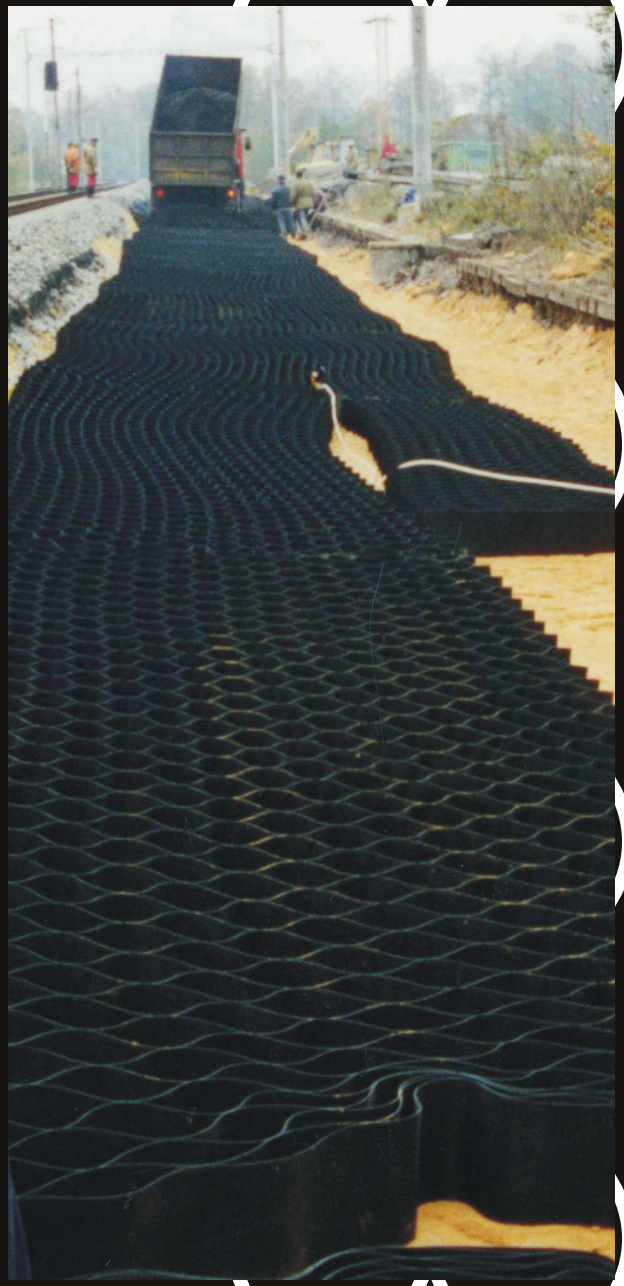
REINFORCED LOADING PLATE

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: E_{pl} **= 57 MPa**.



The measured value of the modulus of deformation of the formation after excavation: E_{0r} **= 4 MPa**.

a) Drainage sand layer, 100 mm thick.
b) Cellular confinement system (geocell), strip width 3,80 m, cells 200 mm (8 in) deep, cell gravel fill fr. 0 – 32 mm.
c) Dune over CCS 50 mm, gravel fr. 0 – 32 mm.
d) Nicotarp100 impermeable membrane
e) Construction layer of the roadbed, gravel fr. 0 – 32 mm, 200 mm thick.



RESULTS OF STRUCTURAL LOAD-BEARING TESTS DONE ON THE ROADBED

The average value of the modulus of deformation measured by a structural loading plate on the roadbed formation: **E_{pl} = 57 MPa**.

REGULATIONS SŽDC

According to the regulation SŽDC S4, Appendix no. 4 for the main national railway tracks, for speed 120 – 160 km (during reconstruction) with minimum requirement on the load-bearing capacity and the compaction rate of the roadbed – modulus of deformation – of the roadbed formation: **E_{pl} = 40 MPa**.

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MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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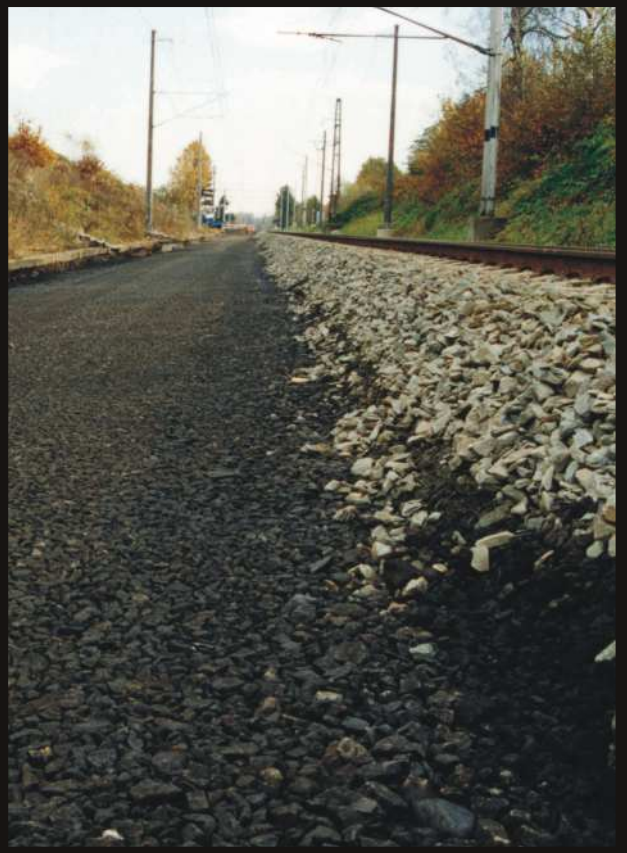

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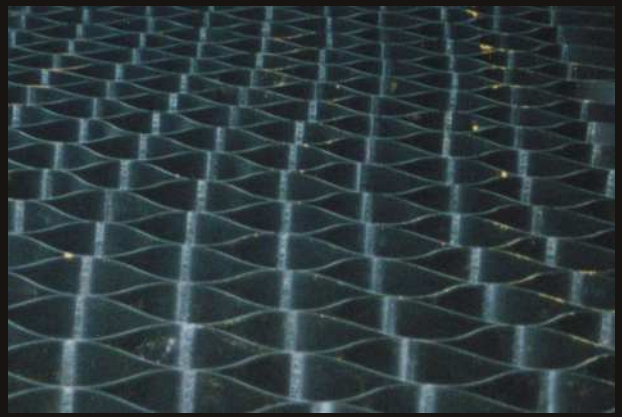
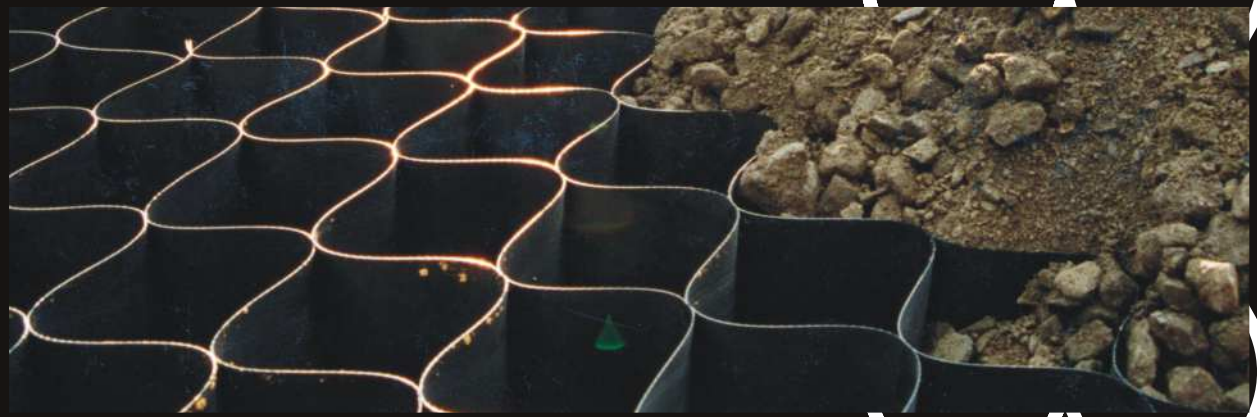




BENDA Trade

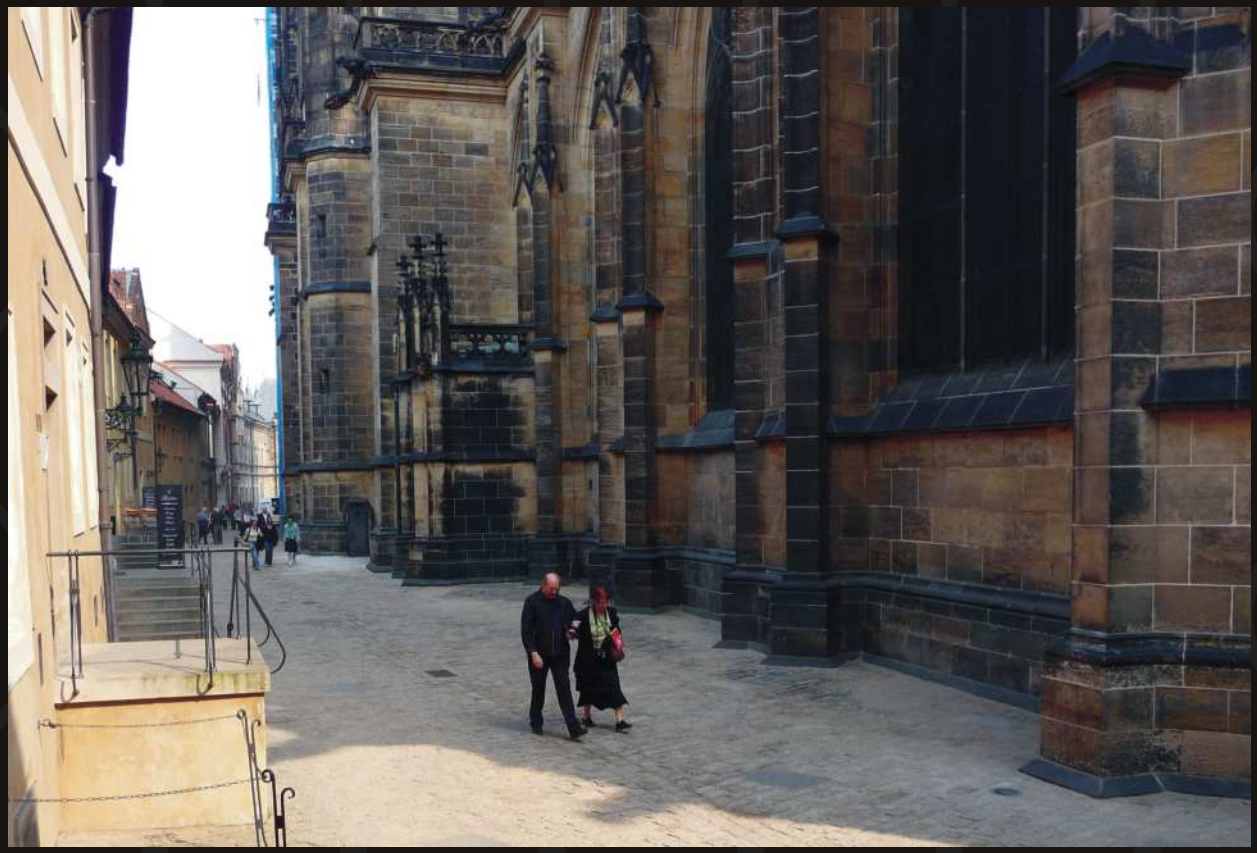
OUR PROJECTS
SUBBASE CONFINEMENT

ROADS, PARKING AREAS, SPECIAL FOUNDATION PROJECTS, OTHER INTERESTING APPLICATIONS

Prague Castle, Prague 1,
Pavement in Jiřské square and Vikářská street

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: SSŽ - stavby silnic a železnic, a.s.
Site: Pražský hrad – Jiřské náměstí



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CONSTRUCTION SPECIFICATION

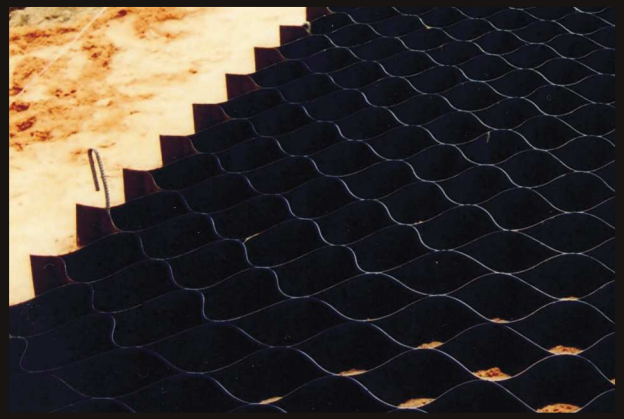
The reinforcement of subbase under the pavement – cobble stones (name of a specific type of pavement produced from quartzite). The subbase was reinforced under the whole of Jiřské square.

Product used:

cellular confinement system (geocell), 100 mm (4 in) deep.

Cell filling material:

dry-mix concrete.



MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day.
- Manual placing without using machinery.
- Possibility to use the original refuse excavated from the site.
- With soil or soil/gravel mixture fill, the area may be subsequently grassed over.

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TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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Implementation phase:

- Technical supervision during the construction process.

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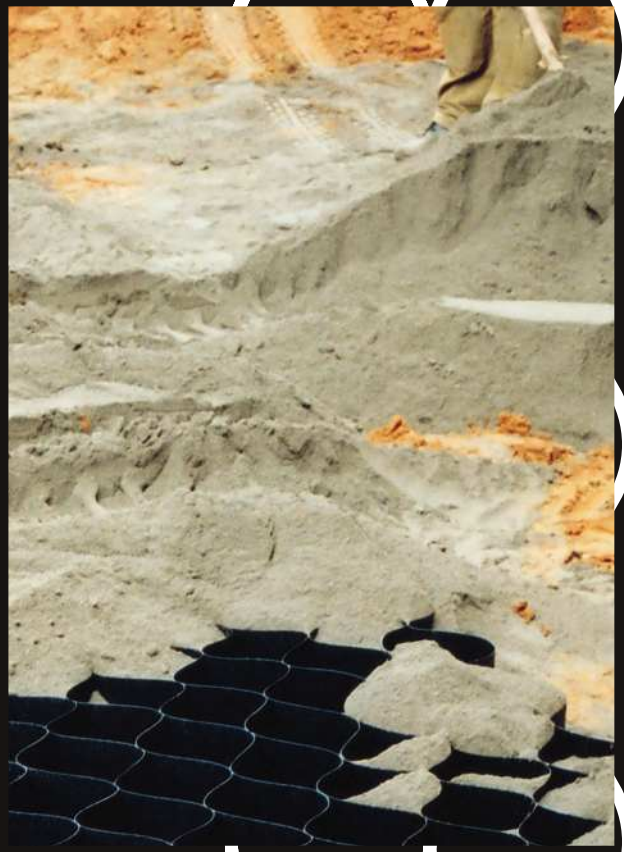

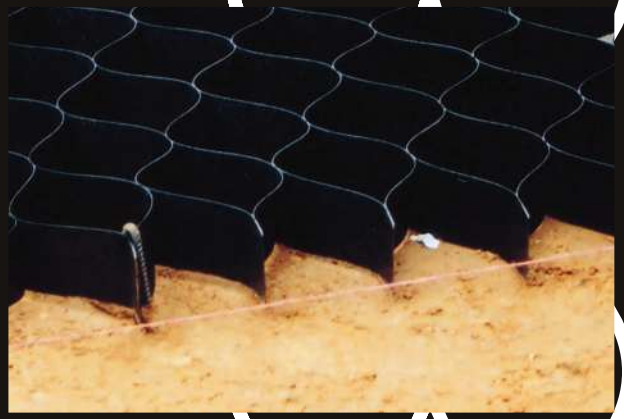

Construction of urban roads

1) Třeboň

Contractor: BENDA TRADE s.r.o.
Client: Lesostavby Třeboň a.s.
Site: Město Třeboň

2) Lysá nad Labem

BENDA Trade

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CONSTRUCTION SPECIFICATION 1

Lesostavby Třeboň a.s.

For the road construction in Třeboň the cellular confinement system (geocell) deep 100 mm (4 in) was used.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day.
- Manual placing without using machinery.
- Possibility to use the original refuse excavated from the site as cell filling material.

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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CONSTRUCTION SPECIFICATION 2

Municipality Lysá nad Labem

Washed sand, refuse excavated from the construction site, was used as cell filling material. The cellular confinement system (geocell) deep 100 mm (4 in) was used. The reason for using the cellular confinement system (geocell) was cables laid at a substantial height, due to which standard construction of the road could not have been applied.

Highway on-ramp
Lipník nad Bečvou

BENDA Trade

PHASE I: Cellular confinement system (geocell) deep 200 mm (8 in).

PHASE II: Cellular confinement system (geocell) deep 100 mm (4 in) installed in two layers.

Site: Lipník nad Bečvou

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PHASE I

PHASE II

CONSTRUCTION SPECIFICATION

The highway on-ramp was built on the trash disposal site. In the first stage the cellular confinement system (geocell) deep 200 mm (8 in) was used. In the second stage the cellular confinement system (geocell) deep 100 mm (4 in) was applied.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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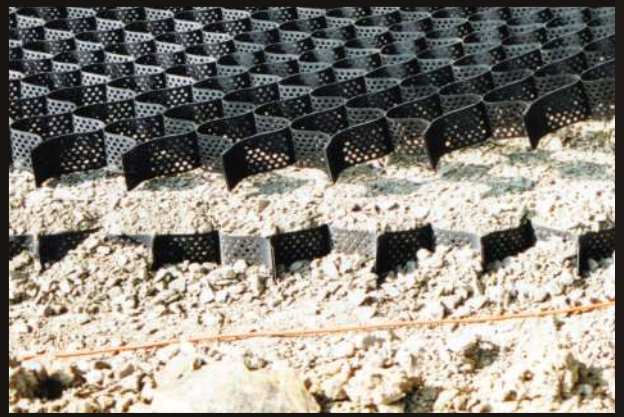

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PHASE II

Driving of collector
with the jet grouting protection
Prague 1 (Wenceslas square)

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Metros s.r.o.
Site: Václavské náměstí, Praha 1

www.benda-trade.cz

CONSTRUCTION SPECIFICATION

Division 1, in association with Subterra a.s, provided building works for a collector C I.A on Vodičkova street, Prague 1. Metrostav constructed the part from Wenceslas Square, through Vodičkova street, up to Palacky street and V Jámě. The driving conditions were extraordinarily difficult, due to the site location in the city center, as well as to the given geological conditions. The driving was performed mostly on a gravel terrace of various grain compositions, in the deepest parts in the area of the Wenceslas Square transitioning to bedrock. In this part of the site there are substantial groundwater affluents. For the reasons stated above it is a high-risk project which was treated with ultimate attention.

The cellular confinement system (geocell), 100 mm (4 in), 150 mm (8 in), and 200 mm (8 in) deep, was used for travel of heavy machinery while driving collector underground.

BENDA Trade

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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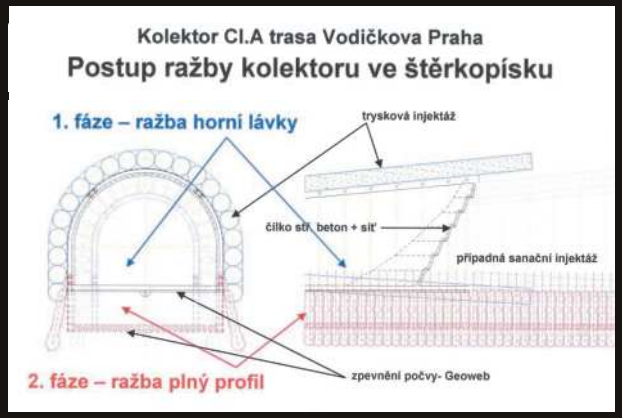

Stabilization of a bridge

Contractor: BENDA TRADE s.r.o.
Client: Stavební společnost Jaroslav Oršuliak s.r.o.
Site: Doly Nástup Tušimice, LOM LIBUŠ II – JIH

Foundation for conveyer belts

Contractor: BENDA TRADE s.r.o.
Client: AGRO Servis
Site: Doly Nástup Tušimice, LOM LIBUŠ II – JIH

BENDA Trade

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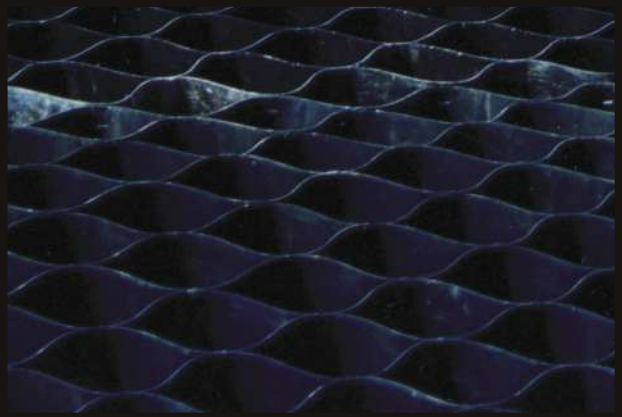
STABILIZATION OF A BRIDGE



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STABILIZATION OF A BRIDGE

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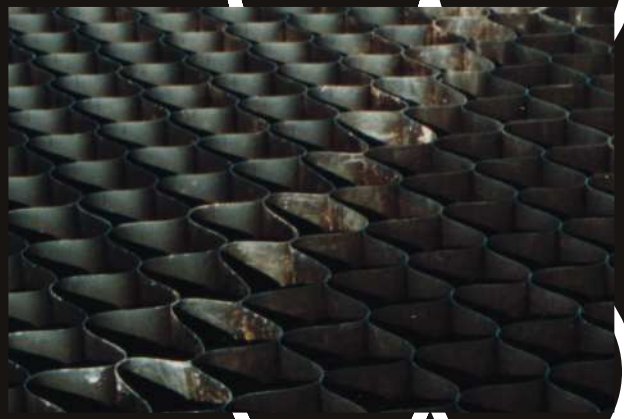
FOUNDATION FOR CONVEYER BELTS



Special foundation projects

BENDA Trade

1) Underpath under I/11 highway in Bystřice nad Olší

Contractor: BENDA TRADE s.r.o.
Client: ALPINE stavební společnost CZ a.s.

2) Foundation for a wagon weighbridge for ČEZ a.s. – Dětmarovice Power Plant

Contractor: BENDA TRADE s.r.o.
Client: UNIGEO a.s.

www.benda-trade.cz

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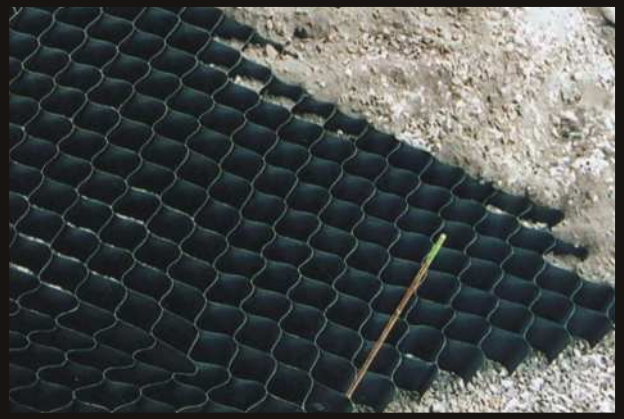
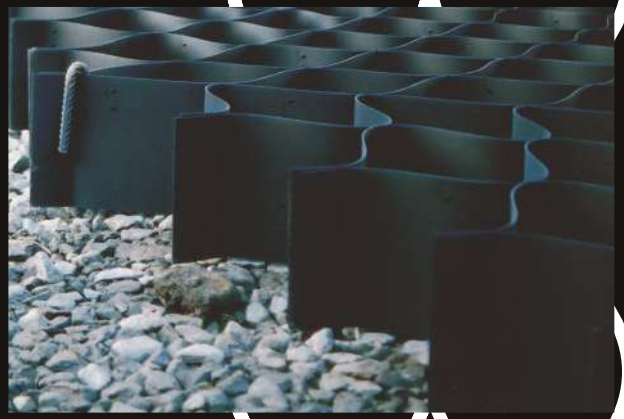
UNDERPATH UNDER I/11 HIGHWAY IN BYSTŘICE NAD OLŠÍ





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FOUNDATION FOR A WAGON WEIGHBRIDGE FOR ČEZ a.s. DĚTMAROVICE POWER PLANT

BENDA Trade

www.benda-trade.cz

FOUNDATION FOR A WAGON WEIGHBRIDGE
FOR ČEZ a.s. DĚTMAROVICE POWER PLANT

Special foundation projects

1) Foundation of a gabion wall, ZOO Ostrava

Contractor: BENDA TRADE s.r.o.
Client: UNIGEO a.s.
Site: Ostrava

2) Retention of subbase under a pipeline Nástup Tušimice Minery

BENDA Trade

www.benda-trade.cz

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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FOUNDATION OF A GABION WALL, ZOO OSTRAVA

BENDA Trade

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RETENTION OF SUBBASE UNDER A PIPELINE
FOR NÁSTUP TUŠIMICE MINERY

Construction of parking areas:

BENDA Trade

1) ZOO Prague – Troja

Contractor: BENDA TRADE s.r.o.
Client: SKANSKA CZ a.s.

2) Domažlice Hospital

Contractor: BENDA TRADE s.r.o.
Client: SSŽ Stavby silnic a železnic a.s.

3) Chomutov

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ZOO Prague – Troja

Domažlice Hospital

CONSTRUCTION SPECIFICATION

Cellular confinement system (geocell), cell depth 100 mm (4 in) was used.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

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BENDA Trade

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Chomutov

ČEZ a.s. – Improvement of a subbase for fuel yards No. 2 and 3

Contractor: BENDA TRADE s.r.o.
Client: ČEZ a.s. – Elektrárna Dětmarovice
Site: Elektrárna Dětmarovice

BENDA Trade

Philips – Hranice na Moravě
Temporary service road, Philips production plant

Contractor: BENDA TRADE s.r.o.
Client: STABA–SERVIS spol. s r.o.
Site: Hranice na Moravě

www.benda-trade.cz

CONSTRUCTION SPECIFICATION 1

ČEZ a.s. – Dětmarovice Power Plant

Construction of access roads around conveyer belts.

Product used:

cellular confinement system (geocell), cell depth 200 mm (8 in).

Cell filling material:

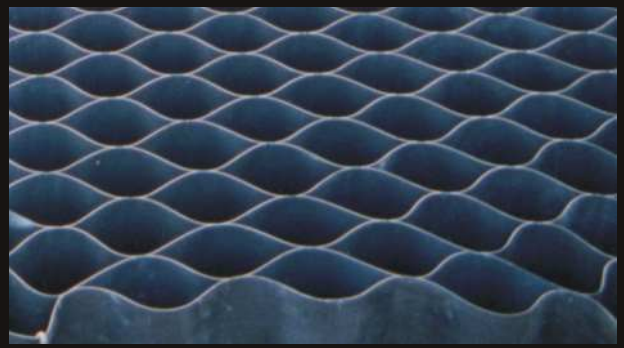
slag, fraction 63 mm.

CONSTRUCTION SPECIFICATION 2

Philips – Hranice na Moravě

Construction of temporary service roads at Philips production plant, Hranice na Moravě.

ČEZ a.s. – DĚTMAROVICE POWER PLANT



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BENDA Trade

PHILIPS – HRANICE NA MORAVĚ

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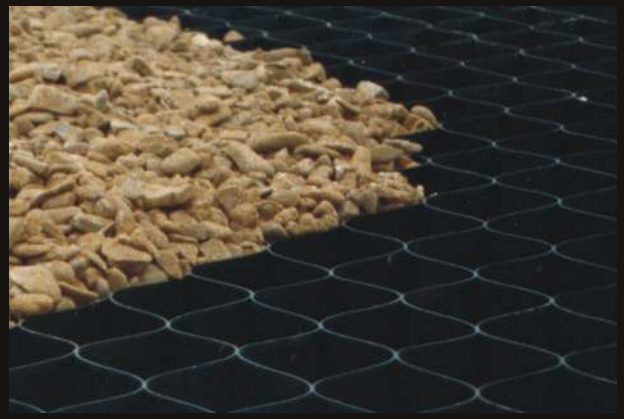


PHILIPS POWER PLANT

The biggest foreign investment in the Czech Republic was realized in Hranice na Moravě where PHILIPS company built two large industrial buildings to produce color TV screens.

Rural road in Češňovice

Contractor: BENDA TRADE s.r.o.
Client: LESOSTAVBY Třeboň, a.s.
Site: Češňovice – České Budějovice

BENDA Trade

Forest ride in Vsetín

Site: Vsetín

www.benda-trade.cz

CONSTRUCTION SPECIFICATION 1

Rural road in Češňovice

Product used:
cellular confinement system (geocell), cell depth 100 mm (4 in).

Cell filling material:
crushed gravel, fraction 0–32 mm.

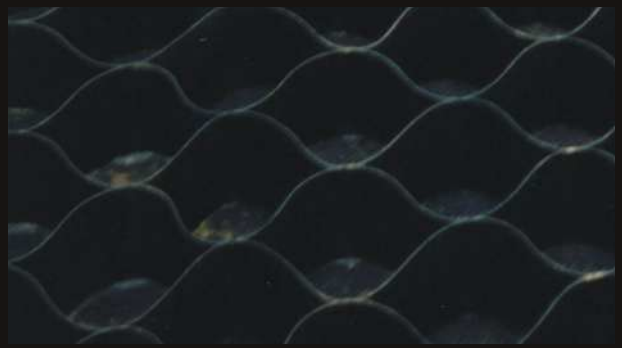
CONSTRUCTION SPECIFICATION 2

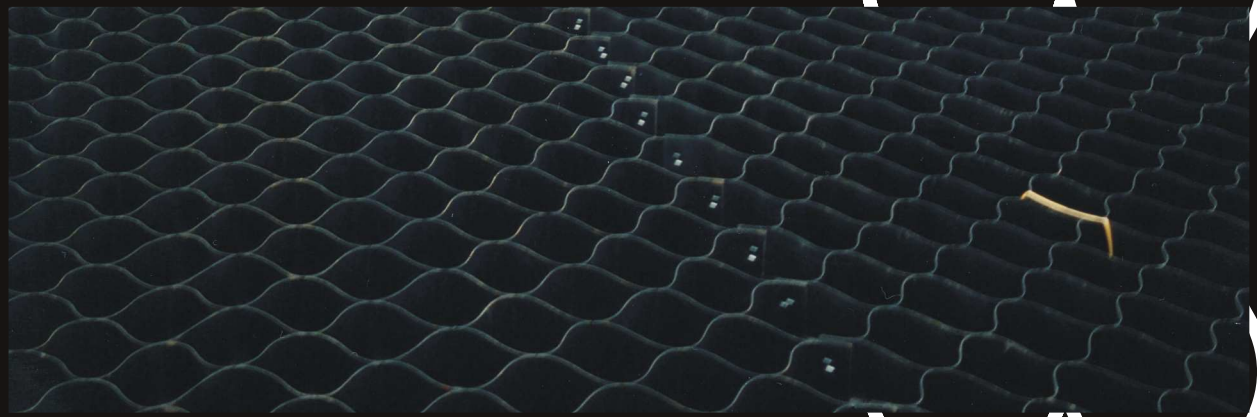
Forest ride in Vsetín

Product used:
cellular confinement system (geocell), cell depth 100 mm (4 in).

Cell filling material:
refuse excavated from the site.

RURAL ROAD IN ČEŠŇOVICE





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FOREST RIDE IN VSETÍN

BENDA Trade

www.benda-trade.cz

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Construction of access and temporary service roads

BENDA Trade

1) Mostecká uhelná společnost a.s.
(Czech Coal Services)

2) Povodí Odry a.s. (Odra River Basin)

www.benda-trade.cz

CONSTRUCTION SPECIFICATION 1

Mostecká uhelná společnost a.s.

Construction of access roads around conveyer belts.

Product used:

cellular confinement system (geocell), cell depth 200 mm (8 in).

Cell filling material:

fly ash with lime admixtures crushed gravel.

CONSTRUCTION SPECIFICATION 2

Povodí Odry a.s.

Construction of access roads to Moravka damn.

Product used:

cellular confinement system (geocell), cell depth 200 mm (8 in).

Cell filling material:

crushed gravel.

MOSTECKÁ UHELNÁ SPOLEČNOST a.s.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
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- Manual placing without using machinery.

POVODÍ ODRY a.s.
Temporary service road to Morávka damn

BENDA Trade

www.benda-trade.cz

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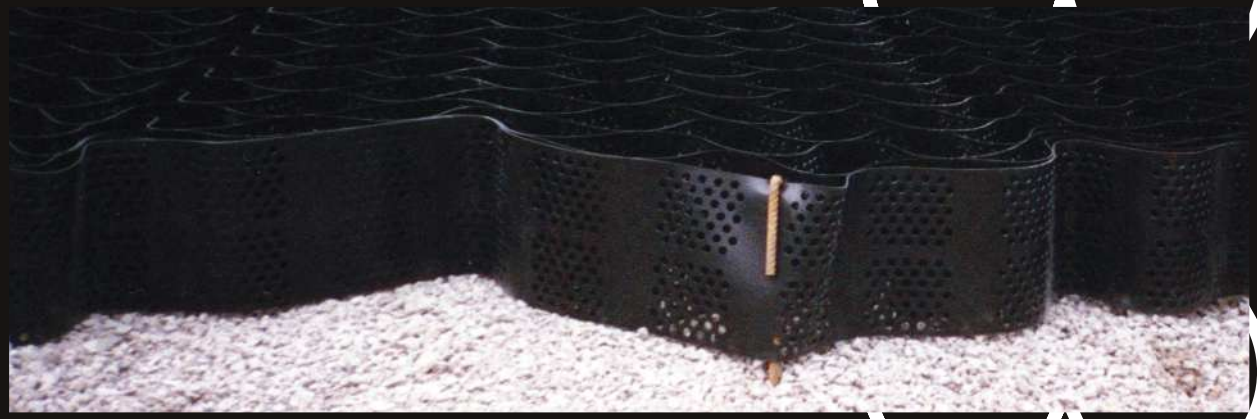

Other interesting applications of subbase confinement

1) Widening of motorway – Svitavy
2) Bridge overpass in Ústí nad Labem

BENDA Trade

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CONSTRUCTION SPECIFICATION 1

Widening of motorway – Svitavy

The cellular confinement system (geocell), 200 mm (8 in) deep, was installed on the excavated formation. Subsequently the cells were backfilled with crushed gravel, fraction 0–63 mm, with a dune 100 mm. The bituminous carpet was laid directly on the compacted dune.

CONSTRUCTION SPECIFICATION 2

Bridge overpass in Ústí nad Labem

The cellular confinement system (geocell), 200 mm (8 in) deep, was laid on a separation geotextile (300 g/m). After installation, the cells were back-filled with a dune of 100 mm above the upper edge of the cell. Crushed gravel, fraction 0-32 mm, was used as the filling material.

WIDENING OF MOTORWAY – SVITAVY

BENDA Trade

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day.
- Manual placing without using machinery.
- Possibility to use the original refuse excavated from the site as cell filling material.

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TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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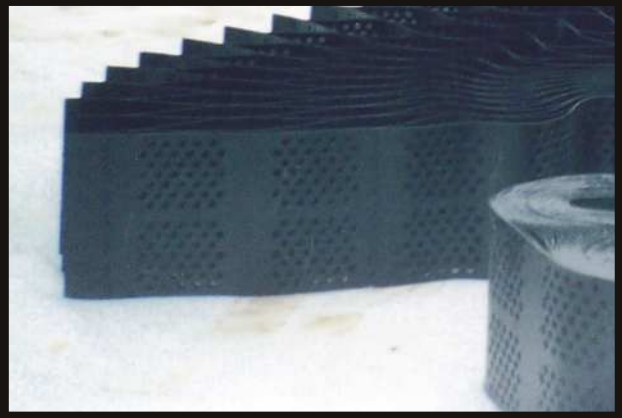
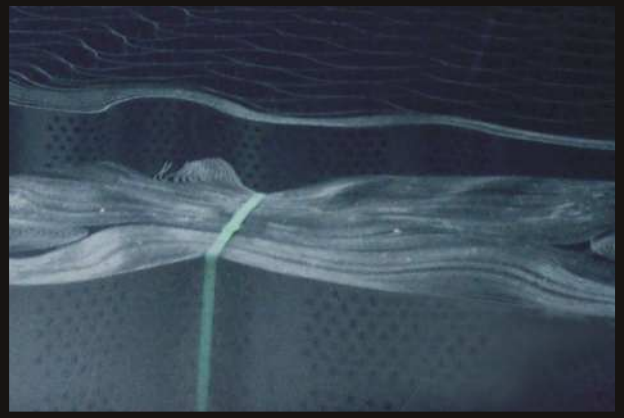
BRIDGE OVERPASS IN ÚSTÍ NAD LABEM





Heavy load carriageway

1) Špejchar – Pelc – Tyrolka Circus

Contractor: BENDA TRADE s.r.o.
Client: ZAKLÁDÁNÍ STAVEB a.s.
Site: Praha – Stromovka

BENDA Trade

2) Temporary service road through fly-ash settling basin

Site: Ostrava

www.benda-trade.cz

ŠPEJCHAR – PELC – TYROLKA CIRCUS

CONSTRUCTION SPECIFICATION 1

Temporary service road for a pile-driving equipment of 100 tones weight.

Product used:

cellular confinement system (geocell), cell depth 200 mm (8 in).

Cell filling material:

construction debris.

CONSTRUCTION SPECIFICATION 2

Product used:

cellular confinement system (geocell), cell depth 200 mm (8 in).

Cell filling material:

excavated fly-ash.

MAIN ADVANTAGES OF THE CELLULAR CONFINEMENT SYSTEM (GEOCELL)

- Significant growth of the load-bearing capacity after installation.
- Significant reduction of tension by overloading on the ground level.
- Decrease of the depth compared to a standard structure built from crushed gravel.
- Heavy machinery may travel on the finished layer immediately, independent of weather conditions.
- Speed of placing: 800 – 1000 m^2 / 1 working group (4 workers) / 1 day.
- Manual placing without using machinery.
- Possibility to use the original refuse excavated from the site.

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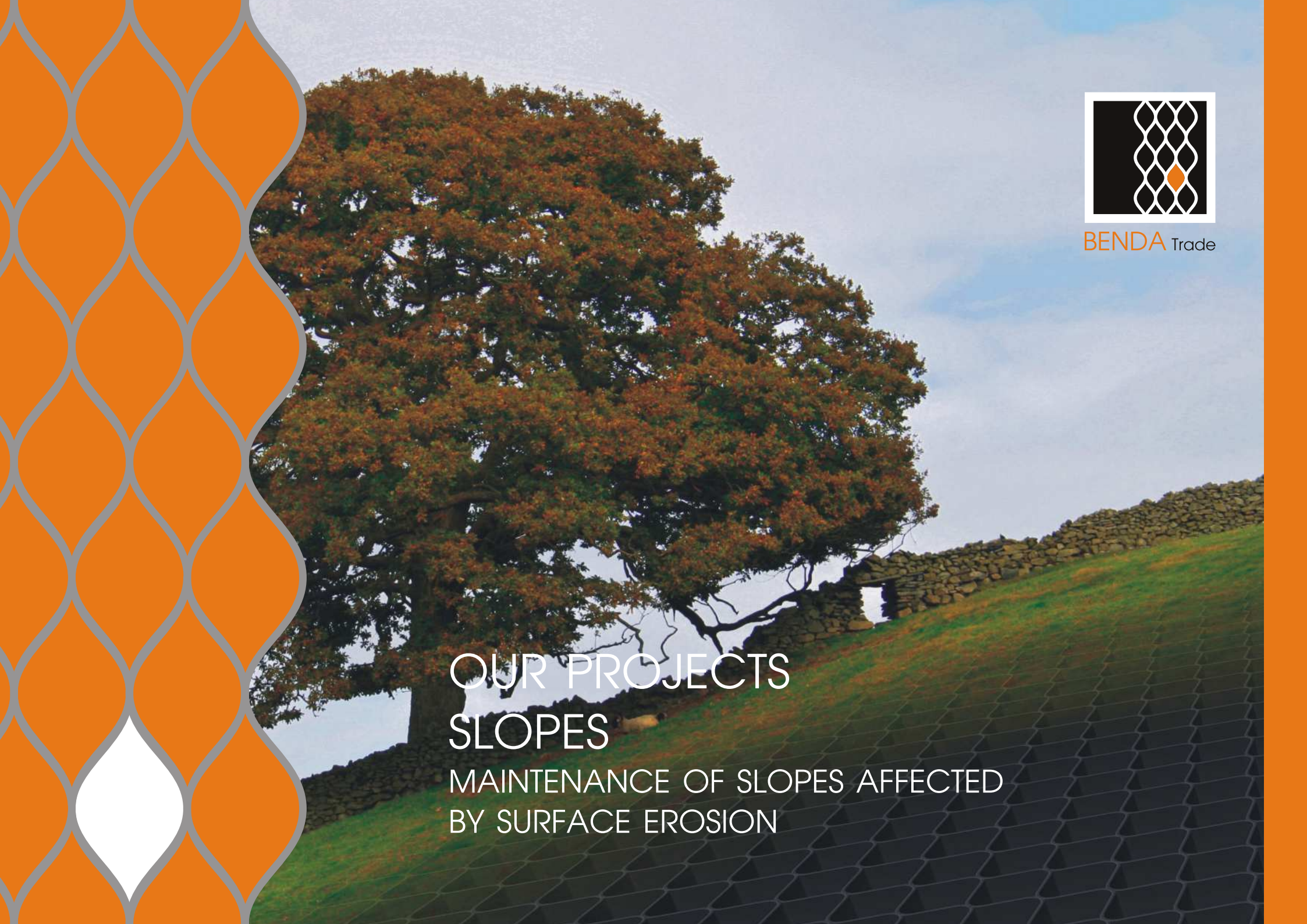
TEMPORARY SERVICE ROAD THROUGH FLY-ASH SETTLING BASIN



BENDA Trade

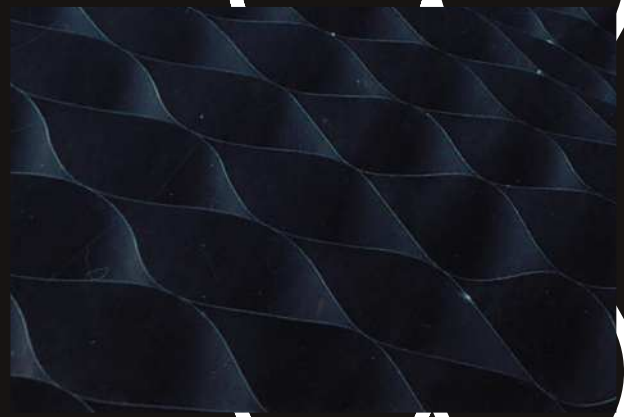
OUR PROJECTS
SLOPES
MAINTENANCE OF SLOPES AFFECTED BY SURFACE EROSION

Maintenance of slopes affected by surface erosion
OBI Pardubice

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: PROFISTAV s.r.o.
Site: Pardubice

www.benda-trade.cz



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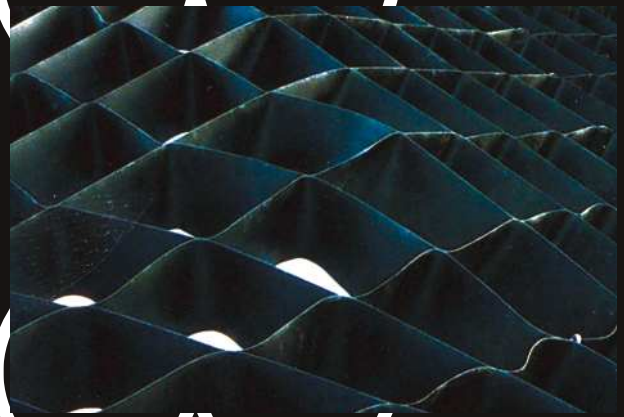

BENDA Trade

www.benda-trade.cz

Maintenance of slopes affected by surface erosion

Shifting of I/7 highway Chomutov – Křimov

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: SSŽ Stavby silnic a železnic a.s.

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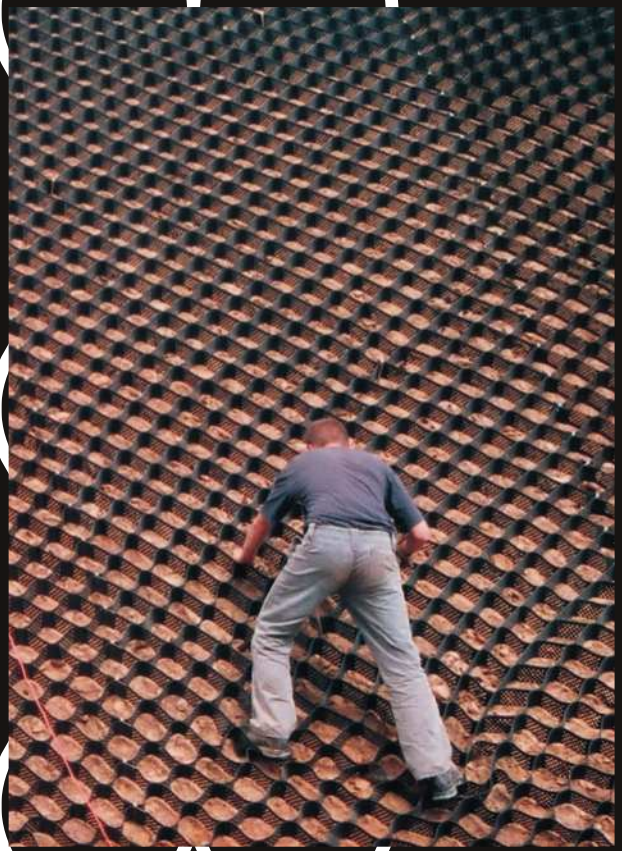

CONSTRUCTION SPECIFICATION

S 11,5/70 category highway in mountainous terrain meeting criteria of a modern capacity highway, especially regarding transport security and ecology. The highway construction is considered as a special architectural achievement. The structure won an award from the State Fund for Transport Infrastructure CR and was nominated for the Structure of the Year award.

TECHNICAL – GEOTECHNICAL SUPPORT PROVIDED BY BENDA TRADE s.r.o.

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Stabilization of slopes affected by surface erosion
Hanspaulka residential area

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: FCC a.s.
Site: Praha

www.benda-trade.cz

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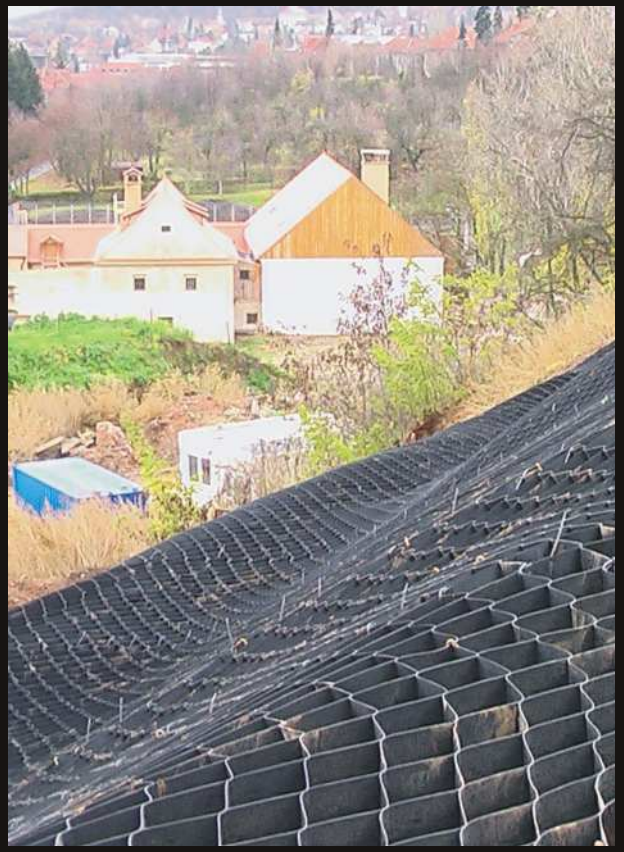

Stabilization of slopes affected by surface erosion around petroleum storage reservoir

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: SILNICE HRADEC KRÁLOVÉ a.s.
Site: Šlapanov

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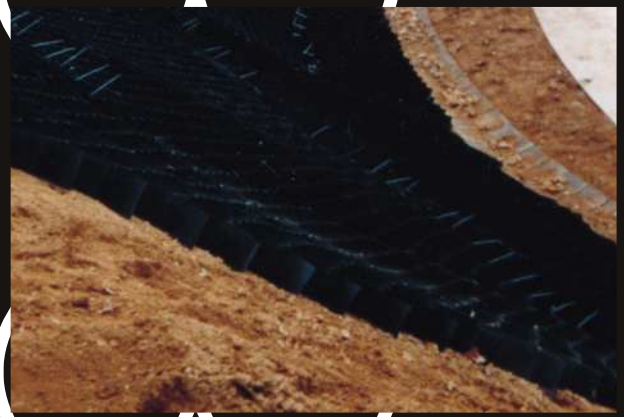

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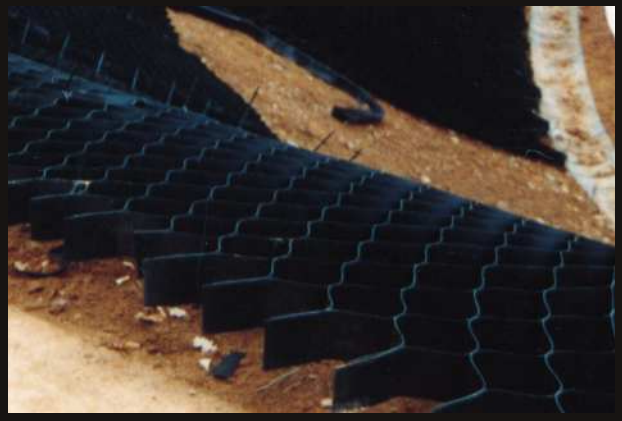
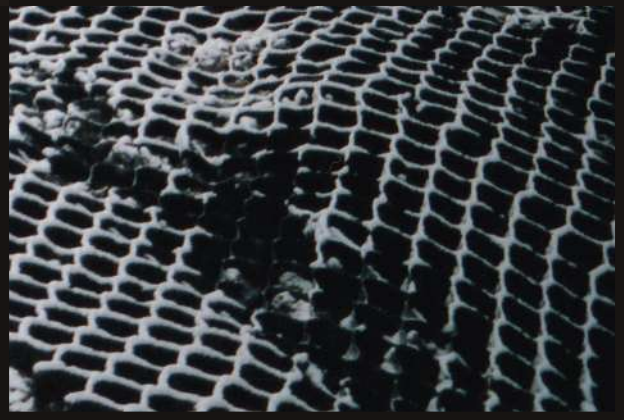


Stabilization of slopes affected by surface erosion
Landek hill, Ostrava

BENDA Trade

www.benda-trade.cz



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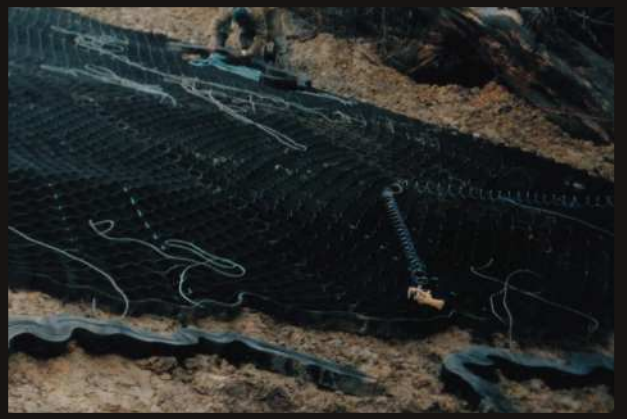

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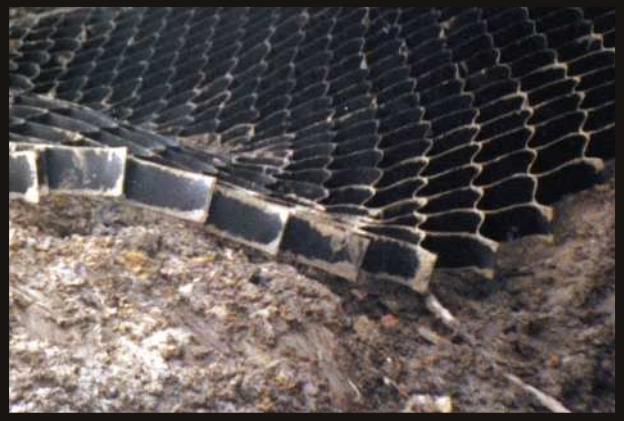

BENDA Trade

OUR PROJECTS

STREAM CHANNELS, DITCHES, RETENTION TANKS

Stabilization of slopes affected by surface erosion

VTP Ostrava (Ostrava Science and Technology Park) – engineering infrastructure – retention tank

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: INGSTAV OSTRAVA, a.s.
Site: Ostrava

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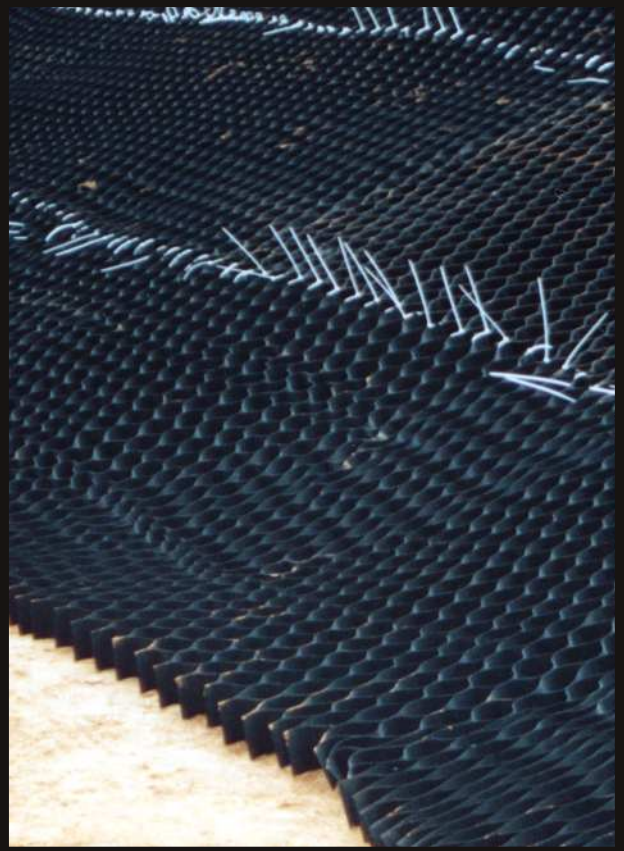

BENDA Trade

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technologický park Ostrava

Residential block of flats Zvonička – lake

Contractor: BENDA TRADE s.r.o.
Client: KONSTRUKTIVA KONSIST a.s.
Site: Praha

BENDA Trade

Prolongation of a sewer A2
Prague 4 Komořany

Contractor: BENDA TRADE s.r.o.
Client: PRAGIS a.s.
Site: Praha

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BYTOVÝ DŮM ZVONIČKA – JEZÍRKO

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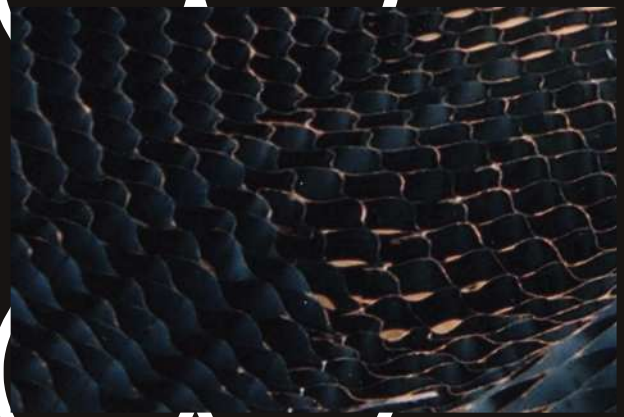
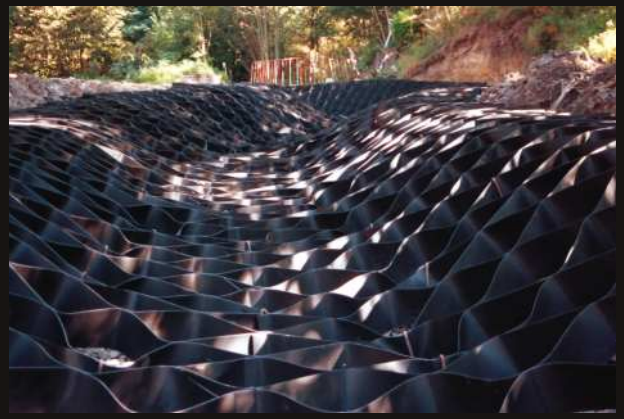


BENDA Trade

RESIDENTIAL BLOCK OF FLATS ZVONIČKA – LAKE

www.benda-trade.cz



Stabilization of slopes affected by surface erosion
Sewerage plant, Lodín

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: STAVOKA KOSICE a.s.
Site: Lodín

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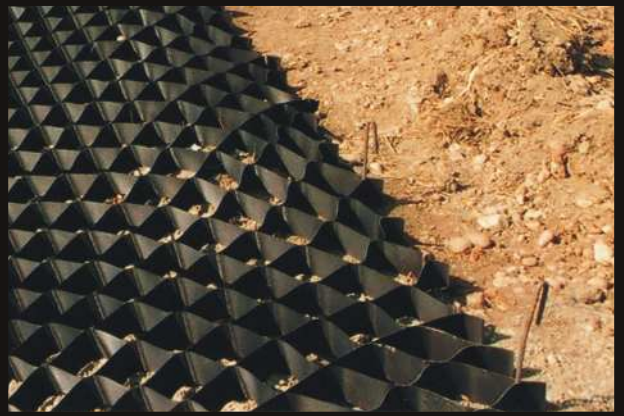

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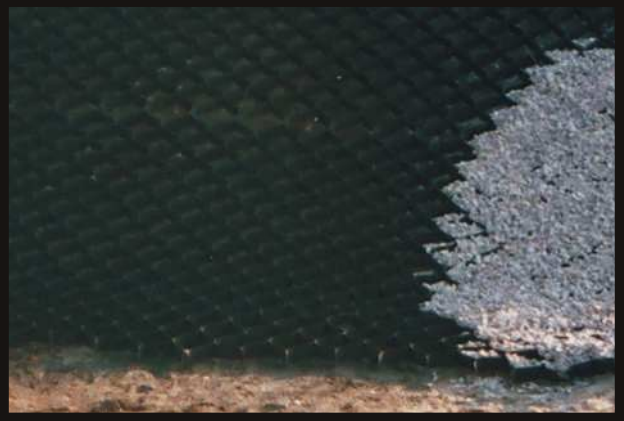

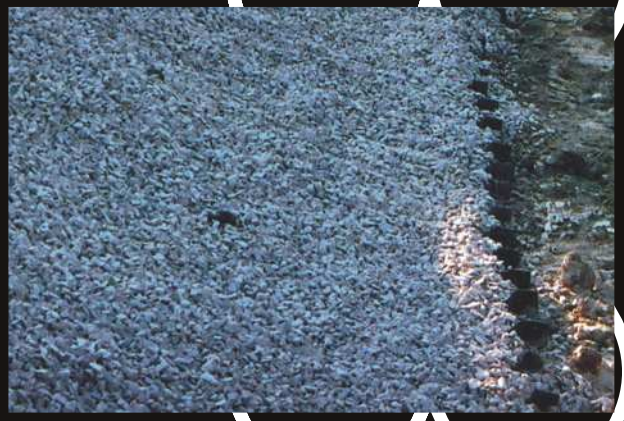

Stabilization of slopes affected by surface erosion

Dike fortification Opava – Palhanec

BENDA Trade

Contractor: BENDA TRADE s.r.o.
Client: Algoman s.r.o.
Site: Opava

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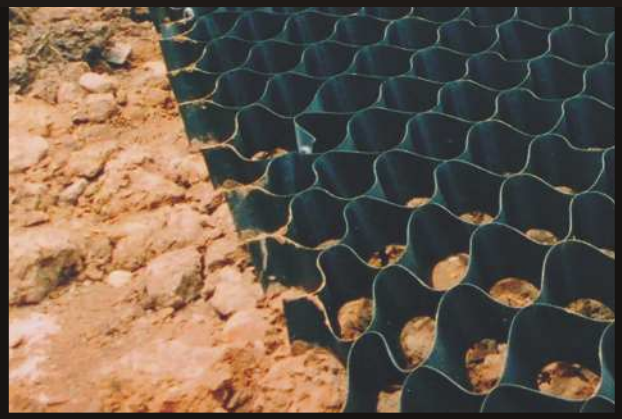

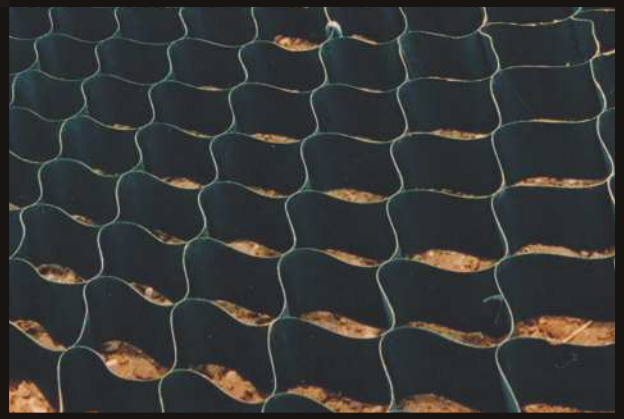

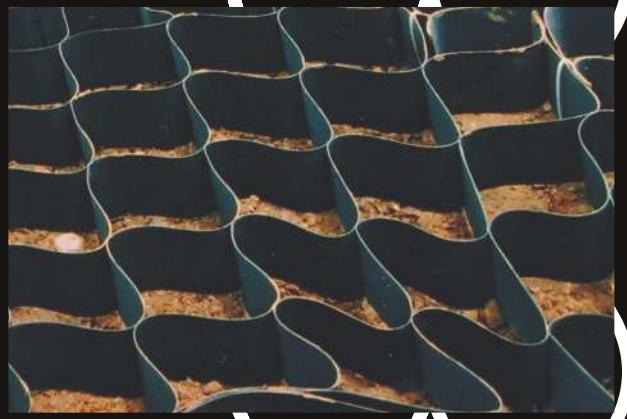

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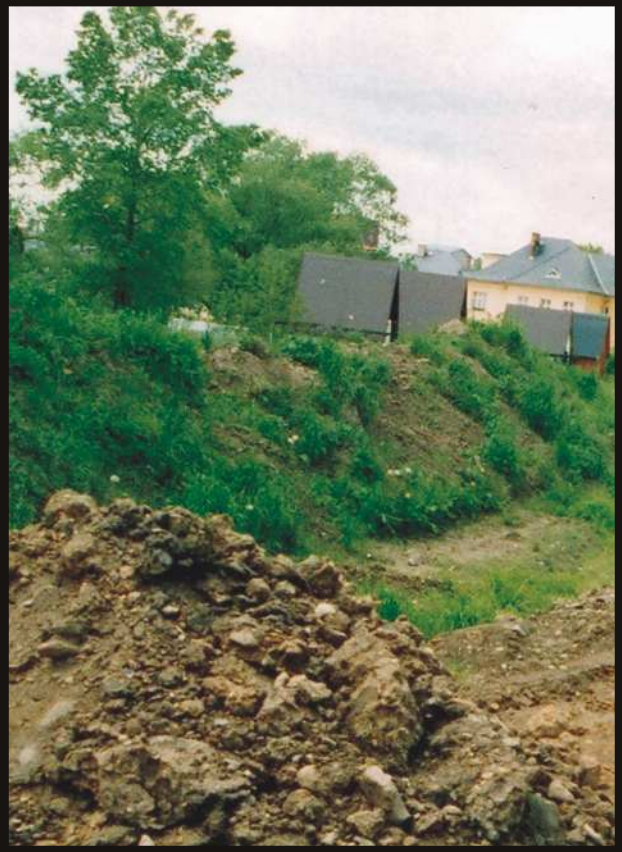
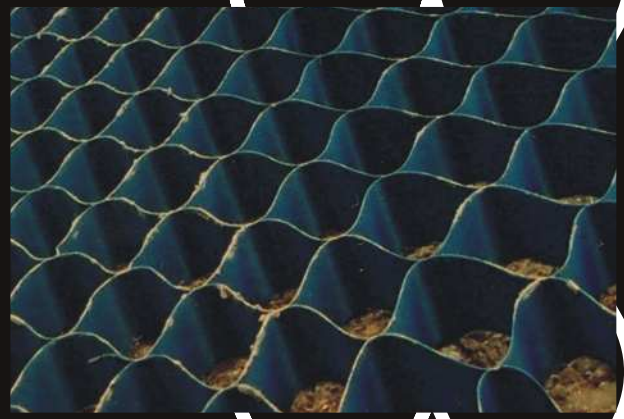
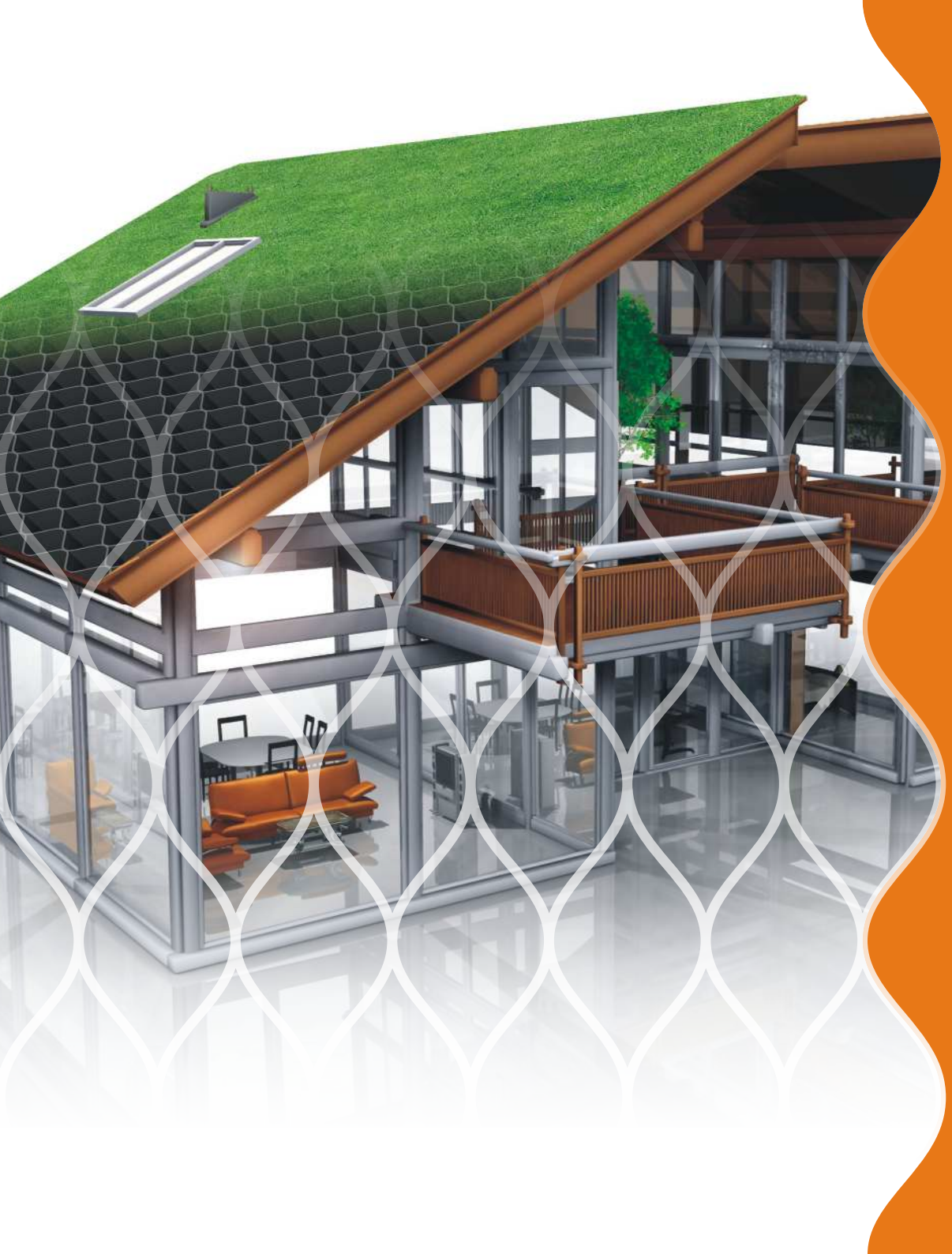






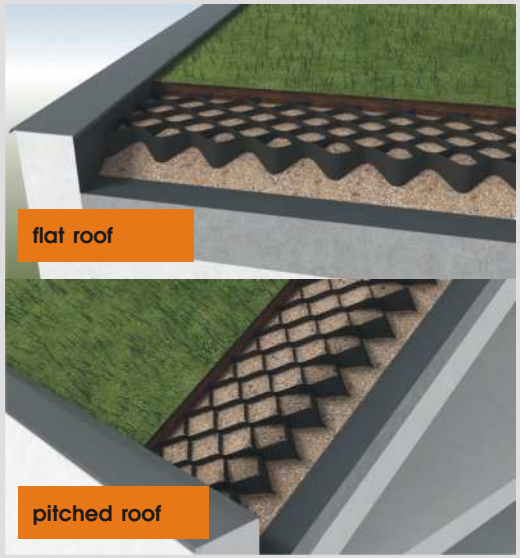
BENDA Trade

OUR NEW PATENTS,

UTILITY MODELS, INTERNATIONAL PCT PATENTS PENDING

www.benda-trade.cz

VEGETATION ROOF, PARTICULARLY THE PITCHED ONE



CERTIFICATE OF UTILITY MODEL REGISTRATION IN CR No: 18456

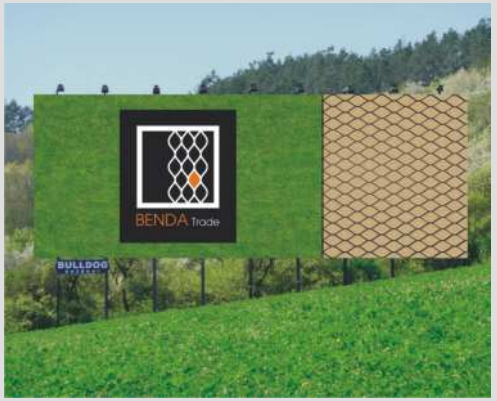
This application is protected by the utility model for CR No: 18456. We have also applied for a registration of a utility model for SR, patent pending for CR and SR, and have several international PCT patents pending for our new applications.

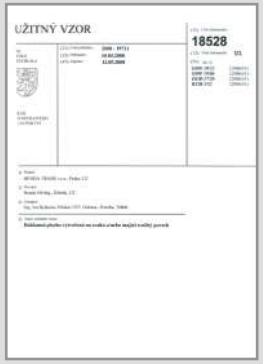
PLEASE NOTE THAT OUR SOLUTIONS ARE INDUSTRIALLY PROTECTED. SOLUTIONS UNDER INDUSTRIAL PROPERTY PROTECTION CANNOT BE USED WITHOUT THE OWNER'S CONSENT. IN CASE OF UNAUTHORIZED USE THE MISUSER RUNS THE RISK OF PENALTY UNDER THE LAW.

BILLBOARDS ESTABLISHED

ON THE EMBANKMENT AND/OR HAVING PITCHING SURFACE

BENDA Trade





CERTIFICATE OF UTILITY MODEL REGISTRATION IN CR No: 18528

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SSŽ – stavby silnic a železnic, a.s.
TCHAS, spol. s.r.o.
MARC-SA Building Systems, s.r.o.
SKANSKA CZ, a.s.
UNIGEO, a.s.
LESOSTAVBY Třeboň, a.s.
TERRA – stavební spol. s.r.o.
Čermák a Hrachovec a.s.
GLOMBICA Jan KOVOSERVIS
Stavební společnost Jaroslav Oršuliak s.r.o.
AGRO Servis , Černovice,
STABA SERVIS spol. s.r.o.
PRAGIS a.s.
Algoman s.r.o.
SESTAV s.r.o.
OKD, Doprava a.s.
STELMAR s.r.o.
SILNICE HRADEC KRÁLOVÉ a.s.
Metros s.r.o.
Chládek a Tintěra a.s.
SKANSKA DS, a.s.
Viamont DSP a.s.
PROFISTAV s.r.o.
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