

**FRISIVERTO –
Your innovative partner
for reinforcements with textile-reinforced concrete**



The future belongs to textile concrete!

FRISIVERTO

Steel reinforced concrete has significant weaknesses:

- It is heavy
- It corrodes and causes damage to the building
- It can be difficult to process
- It is Energy and Resource intensive (sand, quartz materials)

As an innovative alternative, textile concrete has been developed. The grid-like structure of textile fibers of glass, basalt, and carbon replaces or supplements steel in steel reinforced concrete.

Textile carbon fiber reinforcements offer the following critical benefits:

- Efficiency:
 - Durability (especially when strongly exposed to chlorides) - long lifetime, minimum maintenance requirements, and shorter downtime at times when a building is not used
 - Reduction of subsequent costs (maintenance, rehabilitation intervals, rehabilitation work period)
- Sustainability:
 - Less concrete with the same material
 - Recyclability
 - Longer lifetime
- Low weight:
 - Low shipping and installation costs
 - Savings potential when dimensioning reinforcement for a building without compromising on strength
- Strength:
 - Significantly higher strength, compared to the standard structural steels - ideal for fine structures or reinforcement measures
 - Thin layers suffice - thin-walled and lean building style is possible together with applied modern architecture
- Flexibility:
 - Easy installation ideal for rehabilitation works
 - Structural elements with creative shapes are possible

Flexible or rigid lattice structures can be generally applied everywhere where:

- extreme tensile forces act, and where crack formation is to be minimized
- Curved elements need Reinforcement
- difficult and hard-to-reach building locations must be treated
- building weight plays a general role
- reinforcement is to be completed in a very small area



The future belongs to textile concrete! FRISIVERTO

Carbon fiber textile concrete may be used in these areas:

- Rehabilitation of concrete surfaces that have been damaged early in their life cycle due to corroding steel.
- Production of light prefabricates, e.g., for garages, balconies, and noise barriers
- Fine structural elements of buildings, almost not limiting the architects' creativity.
- Facade boards that can be easily manufactured and assembled
- Rehabilitation and reinforcement of bridge structures
- Rehabilitation of roadways to protect them against cracks and bulges
- Rehabilitation of tunnels and sewerage systems
- Concrete water tanks of all kinds to eliminate corrosion and allow for slender structures
- Protection against radar-emitted radiation at airports

Basalt as a sustainable and cost-effective reinforcement material

Textile reinforcements of basalt enables cost-effective reinforcement solutions with:

- high stiffness
- minor dilatation
- corrosion resistance

Reinforcement of textile basalt grids is used as:

- Geotextile in slope strengthening
- Grids for asphalt roads
- Protection against fragments and earthquakes
- the form of resistant non-combustible plates, as a replacement for chipboards, e.g., in warehouses, etc.

Hitexbau, as a subsidiary of the Albani Group, produces lattice structures of textile fibres of carbon, basalt, and glass using state-of-the-art equipment. Besides our ever-expanding range of offered products of carbon and basalt fibers, we offer our business partners products that are customized as per their requirement.

Currently, we hold our licenses for multiple areas:

- General building and technical certificates for Germany
- General approval as building material in the Czech Republic
- General approval for road constructions in the Czech Republic
- Approval for the use with regard to drinking water

Textile concrete enables innovative and sustainable new building



Comparison between steel and carbon concrete

FRISIVERTO

	Efficiency	Sustainability	Fluency/ease.	Strength	Flexibility
Steel concrete	+	-	-	+	-
Carbon concrete	++	+++	+++	+++	+++

New architecture, simple installation (ideal for redevelopment)

Delicate, lean pars

Simple transport, assembly ease

Conservation, durability

Reduction in lifecycle costs (duration, maintenance, no corrosion)



Application example for Carbon concrete FRISIVERTO

Foot bridge in Kempten/Allgäu



The textile concrete bridge is the second of its type and has double length of its predecessor model in the Saxon city of Oschatz.

The assembled bridge made up of 18 segments attains a total length of approx. 17 meters.

The footbridge was planned and dimensioned by researchers of TU Dresden.

The production took place in Oschatz concrete plant in Saxony. The 18 segments with a length of 93 cm each and a wall thickness of only 3 cm were assembled in the workshop and brought to Kempten with a special transporter.

Technical data:

Weight:	12.5 to
Weight per segment:	620 kg
Length:	16.74 m
Used width:	1.75 m
Total width:	2.58 m
Design height:	1.34 m





FRISIVERTO

Application example for Carbon concrete

Redevelopment of arched bridge in Naila/Bavaria

In case of arched bridge in Naila; the structural stability of some components had deteriorated. However, the road safety and durability were affected, which demanded urgent action. The rehabilitation of the structure was unavoidable. All arches had the presence of numerous cracks and clearly recognizable concrete section joints with distinct exfoliation along the entire concrete surface.



After an elaborate examination of all the available redevelopment techniques, the arches were repaired using carbon reinforced concrete, due to its clear advantages. Two layers of carbon grid were installed and covered using spray concrete lining. The thickness of the carbon concrete was only 20 mm in total, which would not have been remotely possible with steel reinforced concrete.





Application example for Carbon concrete

FRISIVERTO

Repair of sugar silos in Uelzen



Major damage was detected after a major fire in a sugar silo. There were very large cracks and concrete bursts visible on the surface. As a result, the sugar silo was no longer usable.

In an expensive investigation, several remediation variants were confronted. There were some key advantages associated with the use of carbon concrete.

On the one hand, the small concrete application for the overcover of the reinforcement and the resulting low own weight, on the other hand by the crack width restriction below 0.1 mm and thus because of the better durability, and ultimately due to the considerable gain in space; the decision was made clearly in favour of carbon concrete.

Sugar silo measurement:

Height 82 m, diameter 45 m

Repair height: 57 m

Repair surface: 4,500 m²

Carbon reinforcement: 14,000 m²



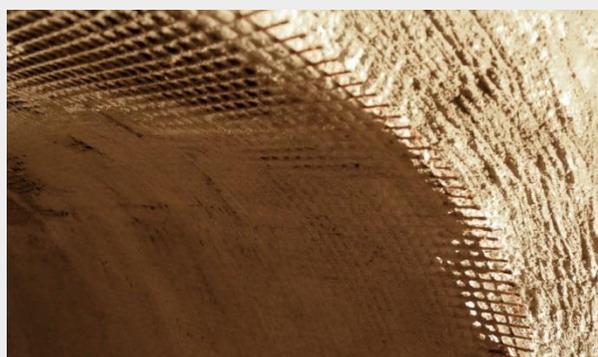


Application example for Carbon concrete

FRISIVERTO

Sewer rehabilitation in Feldafing, Bavaria

The Starzenbach in Feldafing was initiated in a canal of unreinforced concrete in 1954. During new construction and the construction of a road in the immediate vicinity of the canal, it was severely damaged and there was a risk of collapse. Since a repair in an open design was out of the question, it was decided to reinforce and repair the canal with carbon concrete. A reinforcement with steel reinforcement was out of the question for corrosion reasons and because of too much cross-sectional loss due to the necessary concrete cover.



The existing cracks were pressed, and the previous cross-section was reprofiled under the specifications to maintain the previous cross-section. For reinforcement, 2 layers of carbon reinforcement with spray concrete with a total thickness of 20 mm were incorporated.

Channel measurements 180 x 120 cm
Length: 300 m
Carbon reinforcement: 1.400 m²





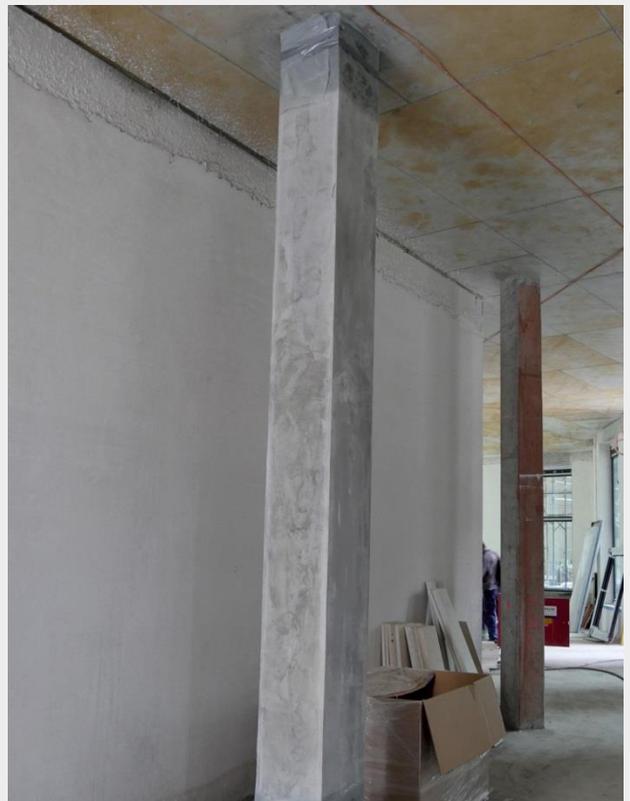
Application example for Carbon concrete FRISIVERTO

Column reinforcement Berlin, Potsdamer Platz

Planning changes during the extension phase of a multi-storey office building in Potsdamer Platz in Berlin required higher load bearing capacity of individual existing square reinforced concrete supports.

In order to ensure this increased load capacity, the supports should be further reinforced with the slightest cross-sectional change, while complying with all fire safety requirements. This could be achieved by replacing it with carbon concrete.

The new static requirements can be achieved by sheathing with 2 layers of carbon reinforcement and a 2.5 cm thick spray concrete layer based on the general technical approval of Z-31.10-182 and the carrying capacity is increased by more than 40%.



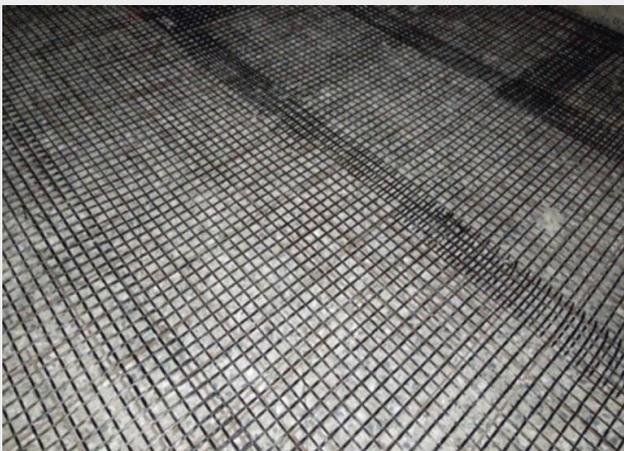


Application example for Carbon concrete

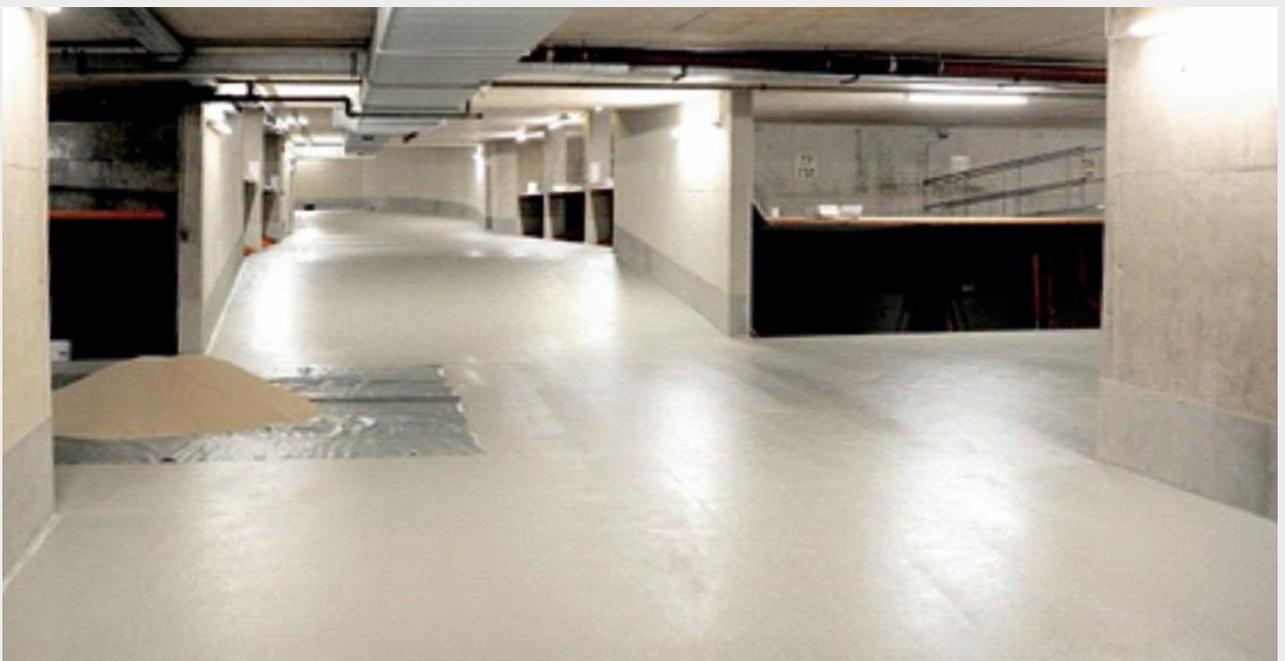
FRISIVERTO

Redevelopment of underground garage in Bayreuth

The underground garage in Bayreuth with a total of 2,500 m² of floor space had to be renovated due to corrosion and displacement in the concrete. There were cracks in entire floor plate that led to the corrosion of the reinforcement steel by de-icing entries. In addition, there was no installation of a gradient towards the drainage facilities.



For restoring durability, an additional layer of concrete was required in order to create a gradient. Due to the low ceiling height of the garage, a carbon reinforcement was used instead of a conventional steel reinforcement. The carbon grid structure was placed close to the surface and covered with a 20 mm concrete layer. A gradient of 2.5% was also incorporated



Advantages of carbon compared with steel



- Higher tensile strength (+600 %)
- Lighter (-80 %)
- Alkali-resistant
- Thinner concrete covering necessary (1 cm)
- Lower crack widths (<0.1 mm)
- Available in rolls (25 m, on customer request)
- Can be used flexibly
- Can be cut to size on-site
- Heat-resistant
- Corrosion-resistant
- Thin-walled components possible
- Delicate concrete structures possible
- More efficient due to lower concrete thickness

Examples of use of carbon reinforcements



- in building elements, load-bearing structures, facade elements as a reinforcing knitted fabric for selected cement screeds, in which it limits the formation of shrinkage cracks and other defects.
- replacement of welded wire meshes
- rehabilitation of concrete structures
- reinforcement of road slabs, tunnels, motorways and airport areas
- reinforcement for use in trafficable and walkable concrete surfaces
- reinforcement of bridges and bridge structures
- prefabricated garages, houses, balconies, noise barriers
- bracing for reinforced-concrete and anhydrite floors
- rehabilitation of constructions
- consolidation of road and railway slopes
- unloading of structural members
- additional strengthening of structures
- consolidation of ceilings of underground garages
- construction of silos and water basins

Advantages of Basalt compared with steel



- 15 % higher tensile strength than glass
- Corrosion-resistant
- Chemical-resistant
- UV-resistant
- High temperature resistance (-250°C to +750°C)
- 100 % recyclable
- Can be milled off
- High sound absorption
- Very cost-effective
- Natural product

Examples of use of basalt reinforcements



- bracing for reinforced-concrete and anhydrite floors
- restoration of road surfaces
- thermal, sound and heat-resistant insulation
- reinforcement of road slabs, tunnels, motorways and airport areas
- reinforcement for use in trafficable and walkable concrete surfaces
- consolidation of road and railway slopes
- reinforcing knitted fabric for selected cement screeds
- bracing for concrete wall and composite panels (slabs)
- earthquake and tremor protection
- consolidation of slopes
- protection against fragments, insects
- specially adapted reinforced knitted fabrics against puncture
- nets with alarm system, in case of cutting through or forced entry

Comparison of the technical data of steel/carbon etc.



		Steel	AR-Glass	Carbon	Aramid	Basalt
Density	g/cm ³	7,85	2,68	1,77	1,44	2,75
Filament diameter	μm		5-14	7	12	9-23
Tensile strength	Mpa	500-700	1.700	3.950	2.900	2.000
Elastic modulus	GPa	210	72	238	60	89
Ageing resistance		-	+	++		-
Price		++	++	--	--	+
Alkali resistance		--	++	++	+	+
Elongation at break		18-26 %	5 %	1,5 %	2,8-4 %	4 %

Comparison of reinforcement of carbon compared with steel



- 1 layer of carbon grid
→ steel diameter 8 mm / every 20 cm

- 4 layers of carbon grid
→ steel diameter 10 mm, every 7.5 cm

Product overview



Material	Art-No.	Yarn	Description	Grid opening (mm)
	SAP		Hitexgrid	Length-/crossways
Carbon	279135	48/12K	HTC 10/15-40	15/10
	279136	48/48K	HTC 21/21-40	22/22
	279137	48/48K	HTC 34/34-40	34/34
	284177	48/48K	HTC 50/50-40	50/50
	284212	24/24K	HTC 25/25-40	27/27
	284214	12/12K	HTC 18/18-40	18/18
	284204	48/48K-UW	HTC 25/25-80-UWX	23/23
	284210	48/24K	HTC 20/50-80-T	50/20
	Basalt	279141	2400 tex	HTB 10/10-40
279140		2400 tex	HTB 22/22-40	22/22
279139		2400 tex	HTB 36/36-40	36/36
Glas	280605	4800 tex	HTG 17/17-40	17/17

All products with 40 degree acrylate coating flexible are also available in 80 degree stiff

Art. 279135
HTC 10/15-40

- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 12K / Density: 1.78 g/cm³
- Binder yarn: PP 110 dtex
- Weight: Approx.: 320 g/m² uncoated
Approx.: 380 g/m² coated

- | | |
|-------------------------------|---|
| ■ Number of threads per meter | ■ Reinforcement cross section per meter |
| Longitudinal: 78 | Longitudinal: 142 mm ² |
| Transversal: 55 | Transversal: 25 mm ² |

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 2551 N/mm² → 362 kN/m
Transversal: 2847 N/mm² → 71 kN/m

□ Elongation

Longitudinal : 1.17 %
Transversal: 1.24 %

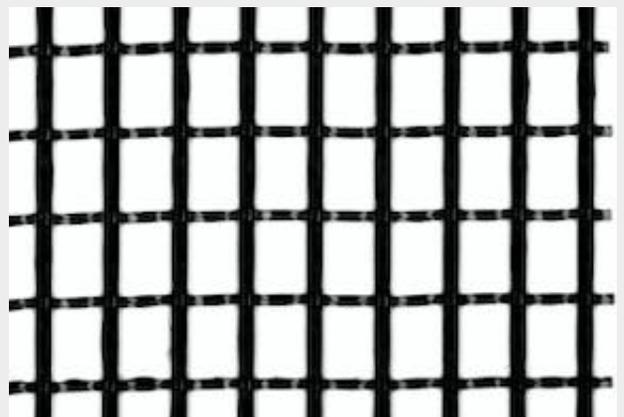
- Coating: Styrol Butadien / Application range up to 40 degrees Celsius

■ Grid opening:

Longitudinal: 15 mm
Transversal: 10 mm

- Working width: 300 cm

- Working length: on demand



Art. 279136
HTC 21/21-40



- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 48K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 255 g/m² uncoated
Approx.: 295 g/m² coated

- Number of threads per meter
 - Longitudinal : 39
 - Transversal: 39
- Reinforcement cross section per meter
 - Longitudinal : 71 mm²
 - Transversal: 71 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 2531 N/mm² → 180 kN/m
Transversal: 2841 N/mm² → 202 kN/m

□ Elongation

Longitudinal : 1.71 %
Transversal: 1.47 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

- Grid opening:
 - longitudinal : 22 mm
 - Transversal: 22 mm

- Working width: 300 cm
- Working length: on demand



Art. 279137
HTC 34/34-40



- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 48K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 175 g/m² uncoated
Approx.: 205 g/m² coated

- Number of threads per meter
Longitudinal : 26
Transversal: 26
- Reinforcement cross section per meter
Longitudinal : 48 mm²
Transversal: 48 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 2544 N/mm² → 122 kN/m
Transversal: 2720 N/mm² → 130 kN/m

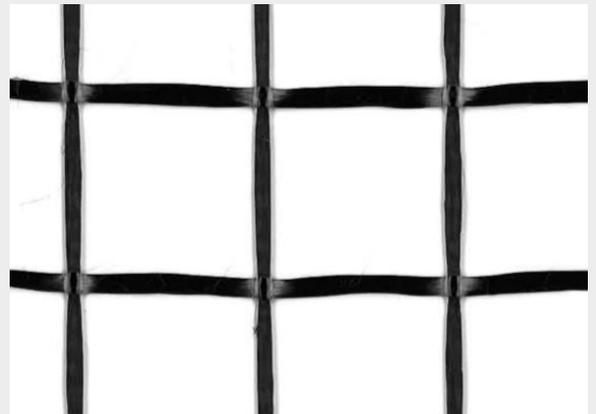
□ Elongation

Longitudinal : 1.47 %
Transversal: 1.34 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

- Grid opening:
Longitudinal: 34 mm
Transversal: 34 mm

- Working width: 300 cm
- Working length: on demand



Art. 284177
HTC 50/50-40

- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 48K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 114 g/m² uncoated
 Approx.: 234 g/m² coated

- | | |
|-------------------------------|---|
| ■ Number of threads per meter | ■ Reinforcement cross section per meter |
| Longitudinal: 19 | Longitudinal: 34 mm ² |
| Transversal: 19 | Transversal: 34 mm ² |

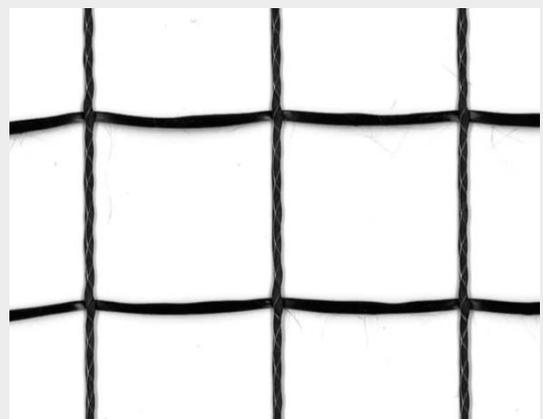
■ Test values according to DIN EN ISO 3341 (mean value)

- | | |
|---|-----------------------|
| □ Tensile strength | □ Elongation |
| Longitudinal : 2551 N/mm ² → 87 kN/m | Longitudinal : 1.40 % |
| Transversal: 2801 N/mm ² → 96 kN/m | Transversal: 1.31 % |

- Coating: Acrylate / Application range up to 40 degrees Celsius

- Grid opening:
- Longitudinal: 50 mm
 Transversal: 50 mm

- Working width: 300 cm
 ■ Working length: on demand



Art. 284212
HTC 25/25-40



- Material, lengthways: Carbon 24K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 24K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 118 g/m² uncoated
Approx.: 140 g/m² coated

- Number of threads per meter
Longitudinal : 34
Transversal: 35
- Reinforcement cross section per meter
Longitudinal : 31 mm²
Transversal: 31 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 2432 N/mm² → 75 kN/m
Transversal: 2801 N/mm² → 88 kN/m

□ Elongation

Longitudinal : 1.47 %
Transversal: 1.34 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

- Grid opening:
Longitudinal: 27 mm
Transversal: 27 mm

- Working width: 300 cm
- Working length: on demand



Art. 284214
HTC 18/18-40



- Material, lengthways: Carbon 12K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 12K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 84 g/m² uncoated
Approx.: 102 g/m² coated

- Number of threads per meter
Longitudinal : 47
Transversal: 50
- Reinforcement cross section per meter
Longitudinal : 21 mm²
Transversal: 22 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 2700 N/mm² → 57 kN/m
Transversal: 3200 N/mm² → 72 kN/m

□ Elongation

Longitudinal : 1.47 %
Transversal: 1.34 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

■ Grid opening:

Longitudinal: 18 mm
Transversal: 18 mm

- Working width: 300 cm
- Working length: on demand



Art. 284204
HTC 25/25-80-UWX



- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 270 g/m² uncoated
Approx.: 310 g/m² coated

- Number of threads per meter
 - Longitudinal : 40
 - Transversal: 40
- Reinforcement cross section per meter
 - Longitudinal : 73 mm²
 - Transversal: 73 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 3150 N/mm² → 229 kN/m
Transversal: 2670 N/mm² → 194 kN/m

□ Elongation

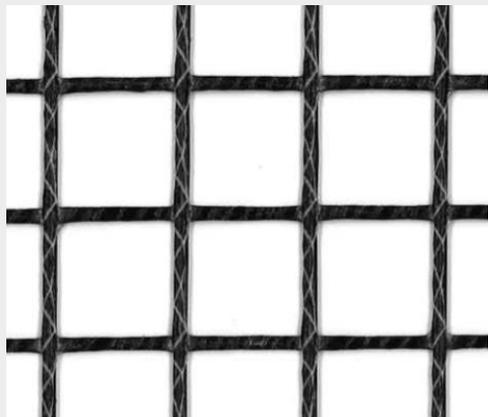
Longitudinal : 2.2 %
Transversal: 1.9 %

- Coating: stiff / Application range up to 80 degrees Celsius

■ Grid opening:

lengthways: 23 mm
crossways: 23 mm

- Working width: 300 cm
- Working length: on demand



Art. 284210
HTC 20/50-80-T

- Material, lengthways: Carbon 48K-entwined / Density: 1.78 g/cm³
- Material, crossways: Carbon 24K / Density: 1.78 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 195 g/m² uncoated
 Approx.: 265 g/m² coated

- | | |
|-------------------------------|---|
| ■ Number of threads per meter | ■ Reinforcement cross section per meter |
| Longitudinal : 48 | Longitudinal : 87 mm ² |
| Transversal: 20 | Transversal: 18 mm ² |

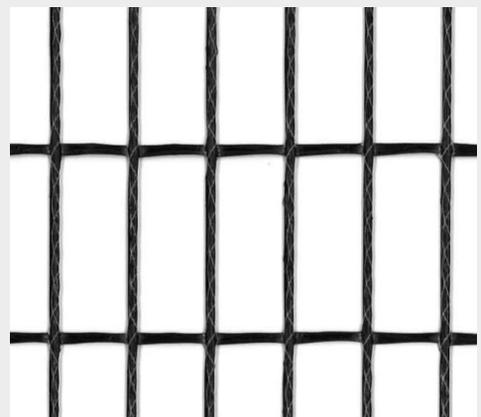
■ Test values according to DIN EN ISO 3341 (mean value)

- | | |
|--|----------------------|
| □ Tensile strength | □ Elongation |
| Longitudinal : 3250 N/mm ² → 282 kN/m | Longitudinal : 2.3 % |
| Transversal: 2770 N/mm ² → 50 kN/m | Transversal: 1.9 % |

- Coating: stiff / Application range up to 80 degrees Celsius

- Grid opening:
 Longitudinal: 50 mm
 Transversal: 20 mm

- Working width: 300 cm
- Working length: on demand



Art. 279141
HTB 10/40-40



- Material, lengthways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Material, crossways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 335 g/m² uncoated
Approx.: 375 g/m² coated

- Number of threads per meter
Longitudinal : 84
Transversal: 61
- Reinforcement cross section per meter
Longitudinal : 73 mm²
Transversal: 53 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 1355 N/mm² → 99 kN/m
Transversal: 1251 N/mm² → 66 kN/m

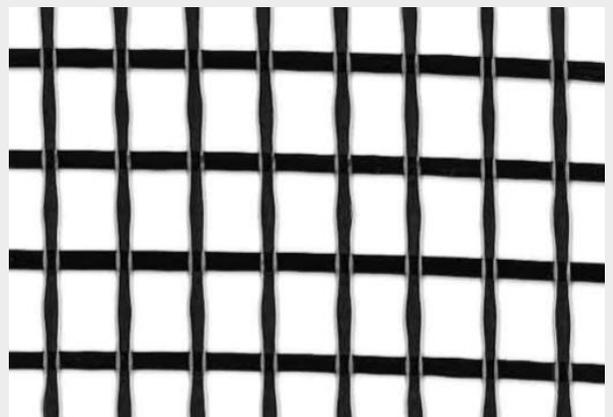
□ Elongation

Longitudinal : 1.56 %
Transversal: 1.32%

- Coating: Acrylate / Application range up to 40 degrees Celsius

- Grid opening:
Longitudinal: 14 mm
Transversal: 10 mm

- Working width: 300 cm
- Working length: on demand



Art. 279140
HTB 22/22-40



- Material, lengthways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Material, crossways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 205 g/m² uncoated
Approx.: 229 g/m² coated

- Number of threads per meter
Longitudinal : 43
Transversal: 42
- Reinforcement cross section per meter
Longitudinal : 37 mm²
Transversal: 36 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 1068 N/mm² → 39 kN/m
Transversal: 1347 N/mm² → 48 kN/m

□ Elongation

Longitudinal : 1.61 %
Transversal: 1.63 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

■ Grid opening:

Longitudinal: 22 mm
Transversal: 22 mm

- Working width: 300 cm
- Working length: on demand



Art. 279139
HTB 36/36-40



- Material, lengthways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Material, crossways: Basalt 2400 Tex / Density: 2.75 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 136 g/m² uncoated
Approx.: 153 g/m² coated

- Number of threads per meter
lengthways : 26
crossways: 25
- Reinforcement cross section per meter
lengthways : 23 mm²
crossways: 22 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 1141 N/mm² → 26 kN/m
Transversal: 1279 N/mm² → 28 kN/m

□ Elongation

Longitudinal : 1.62 %
Transversal: 1.54 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

■ Grid opening:

Longitudinal: 36 mm
Transversal: 36 mm

- Working width: 300 cm
- Working length: on demand



Art. 280605
HTG 17/17-40



- Material, lengthways: Glas 4800 Tex / Density: 2.46 g/cm³
- Material, crossways: Glas 4800 Tex / Density: 2.46 g/cm³
- Binder yarn: PES 167 dtex
- Weight: Approx.: 510 g/m² uncoated
Approx.: 585 g/m² coated

- Number of threads per meter
Longitudinal : 59
Transversal: 59
- Reinforcement cross section per meter
Longitudinal : 115 mm²
Transversal: 115 mm²

■ Test values according to DIN EN ISO 3341 (mean value)

□ Tensile strength

Longitudinal : 1200 N/mm² → 138 kN/m
Transversal: 1200 N/mm² → 138 kN/m

□ Elongation

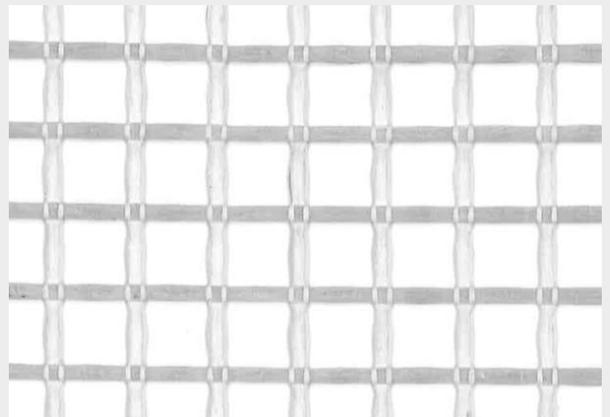
Longitudinal : 2.9 %
Transversal: 2.9 %

- Coating: Acrylate / Application range up to 40 degrees Celsius

■ Grid opening:

Longitudinal: 17 mm
Transversal: 17 mm

- Working width: 300 cm
- Working length: on demand



Point of contact



FRISIVERTO

■ **Frisiverto s.r.o.**

Veronika Blechová
Libavské Údolí 44
CZ-35751 Libavské Údolí

Tel.: +420 352 370 370
Mobil: +420 736 622 675
frisiverto@frisiverto.cz
www.frisiverto.cz

® TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague, SOE

Akreditovaná zkušební laboratoř, Autorizovaná osoba, Notifikovaná osoba, Oznamovaný subjekt, Subjekt pro technické posuzování, Certifikační orgán, Inspekční orgán •
Accredited Testing Laboratory, Authorized Body, Notified Body, Technical Assessment Body, Certification Body, Inspection Body • Prosecká 81/ 76a, 190 00 Praha 9 -
Prosek, Czech Republic

Authorised Body No. 204 according ÚNMZ Decision No. 5/ 2017
Branch Office 0600 - Brno

issues

pursuant to Act No. 22/1997 Coll., on technical requirements for products and on modification and amendment of some laws,
as amended, and Sections 2 and 3 of Government Regulation No. 163/2002 Coll., as amended by Government Regulation No.
312/2005 Coll., and Government Regulation No. 215/2016 Coll., issues

BUILDING TECHNICAL CERTIFICATE

No. 060-047196

for the product:

Basalt reinforcement for road construction

Type / variant: **HTB 10/ 14 - 40, HTB 22/ 22 - 40,**
HTB 36/36 - 40

Manufacturer:

Alligard s.r.o.

ID No. 25200933
Address: Descriptive number 44, 357 51 Libavské Údolí
factory: **Alligard s.r.o.**
ID No. 25200933
Address: Descriptive number 44, 357 51 Libavské Údolí
Order: Z060170211

Authorised Body 204 verifies by this Building Technical Certificate the data on the product's technical properties, their level and the procedures of their detection in relation to the basic requirements stated in Annex 1 of Government Regulation No. 163/2002 Coll., as amended by Government Regulation No. 312/2005 Coll., and Government Regulation No. 215/2016 Coll.

The certificate is the technical specification intended for assessing the conformity of a specified product.

Number of pages of the building technical certificate including the title page: 3

Processor of this building technical certificate:


Ing. Marek Sopko
Lead Assessor

Certificate validity: 31 August 2021 Person responsible for the correctness of this building technical certificate:

Brno, 10 August 2018




Ing. Jozef Pöbiš
Head of authorised body 204

1 Description of the product and specification of its use in construction:

Carbon reinforcement for concrete structures and road construction in the form of meshes of non-corrodible, alkali-resistant carbon fibres, continuously coated with modified polymers. The meshes achieve their tensile strengths in the range of 50 to 470 kN per 1 meter of width, depending on the mesh type, based on the fibre diameter, strand frequency, and fibre type.

The carbon reinforcement in the form of meshes is designed for non-structural use, in particular to reduce shrinkage, surface layer reinforcement or manipulate and reinforce concrete structures and components designed for aggressive environments and concrete and asphalt-concrete roads.

At the mesh connection points, there are carbon fibre strands that are connected and fixed with 110 dtex polypropylene yarn. To achieve shift resistance and better cohesion with concrete, the carbon reinforcement is coated with styrene-butadiene or acrylate.

In road construction, there the carbon reinforcement enables trouble-free milling and recycling of worn-out asphalt-concrete layers, ensures better load distribution in the road construction and more uniform sedimentation, and when properly designed, it reduces the total road pavement layer thickness.

Tab. 1 Specification of reinforcements

No.	Type	Mesh size transversal/longitudinal [mm]	Fibre type		Coating type
			Longitudinally	Transversally	
1	HTC 10/15-40	10 / 15	Carbon 48K	Carbon 12K	Styrol-butadiene
2	HTC 21/21-40	21 / 21	Carbon 48K	Carbon 48K	Acrylate
3	HTC 34/34-40	34 / 34	Carbon 48K	Carbon 48K	Acrylate
4	HTC 9/14-40	9 / 14	Carbon 48K	Carbon 12K	Acrylate

2 Specification of the monitored properties and the assessment method:

Tab. 2

No.	Monitored property	Test procedure	Number of		Desired (P) / Declared level (D)
			C/T	D	
1	Tensile strength per 1 m of width	ISO 10406-1, Chap. 6	10	5	D: HTC 10/15-40 In the warp direction (WARP): min. 420 In the weft direction (WEFT): min. 50 HTC 21/21-40 In the warp direction (WARP): min. 200 In the weft direction (WEFT): min. 200 HTC 34/34-40 In the warp direction (WARP): min. 110 In the weft direction (WEFT): min. 110 HTC 9/14-40 In the warp direction (WARP): min. 470 In the weft direction (WEFT): min. 60
2	Tensile strength Relative elongation	ISO 10406-1, Chap. 6	10	5	Carbon 12K: D: $f_{u,c}$ min. 800 MPa D: ϵ_u : 1,1 % to 1.4% Carbon 48K: D: $f_{u,c}$ min. 700 MPa D: ϵ_u : 0,9% to 1.2%
3	Modulus of elasticity	ISO 10406-1, Chap. 6.4.4	10	5	Carbon 12K: D: E: min. 80 GPa Carbon 48K: D: E: min. 70 GPa
4	Resistance to increased temperature	ISO 10406-1, Chap. 6	5	5	D: $R_{et} > 80\%$: Conditioning at 200°C for 6 hours
5	Strength of mesh joints	CSN EN ISO 15630-2	5	5	D: min. 15 N
6	Resistance to alkaline environment	ISO 10406-1, Chap. 11	5	5	D: $R_{et} > 90\%$:
7	Reinforcement diameter	ISO 10406-1, Chap. 5	3	3	D: tolerance -5% / +10%
8	Dimensional network	HTC 10/420139	3	3	D: tolerance $\pm 10\%$
9	Fibre weight content	ČSN EN ISO 1172	2	2	D: min. 80%
10	Cadmium contents	Methodology No.	1	1	D: max. 0.01 %

Note: C - Product certification (Art. 5, 5a, 6, 10); T - Verification/Assessment of product conformance (Art 7, 8); D - Certified product monitoring (Art. 5, 5a, 6, 10)

3 Production control system securing

The general requirements for the manufacturer's production control system are set out in Annex 3 to Government Decree No. 163/2002 Coll., as amended.

4 Documentation submitted by the manufacturer:

- Request for assessment by Authorized Body 204, of 2 November, 2017
- Carbon reinforcement technical sheets

5 Overview of the applicable technical regulations, technical standards, and other documents:

- Act No. 22/1997 Coll., on the technical requirements for products, as amended
- Government Decree No. 163/2002 Coll., laying down the technical requirements for selected construction products, as amended by Government Decree No. 312/2005 Coll. and Government Decree No. 215/2016 Coll.
- ISO 10406-1 Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
- ČSN EN ISO 15630-2 Steel for concrete reinforcement and prestressing - Test methods - Part 2: Welded meshes
- ČSN 42 0139 Steel for concrete reinforcement - Welded concrete high-bond bars and smooth steel
- ČSN EN ISO 1172 Textile glass - Reinforced prepregs (pre-impregnated laminates), press mixtures, and laminates - Determination of textile glass and mineral filler content - Calcination method
- Methodology No. 100611-01 Determination of metals in a mineralized sample: AAS - flame
- Technical Instructions 01.02.C Composite reinforcement based on glass or carbon fibres or a combination thereof
- Technical Instructions 01.02.a Welded meshes of ladder and smooth wires

6 Verification Tests

No verification tests were performed for the purpose of issuing the construction technical certificate.

7 Specific requirements for conformity assessment:

- The product is classified in Annex 2, group 01, item 2, per Government Decree No. 163/2002 Coll., as amended, and the prescribed conformity assessment method is in accordance with Article 5 of the specified Decree. The manufacturer secures its production control system in accordance with the requirements of Art. 5 par. 1 let. c of the specified Decree.
- The certified product will be inspected every 12 months.

**® TECHNICAL AND TEST INSTITUTE FOR CONSTRUCTION
PRAGUE, SOE**

Technical and Test Institute for Construction Prague

Accredited Testing Laboratory, Authorized Body, Notified Body, Technical Assessment Body, Certification Body,
Inspection Body. Prosecká 811 /76a, 190 00 Prague 9 - Prosek, Czech Republic

**Authorized Body 204 per the decision of the Czech Office for Standards, Metrology, and Testing
No. 5/2017**

Branch 0600 - Brno

issues,

following the provisions of Act No. 22/1997 Coll., on technical requirements for products and amending and
supplementing certain acts, as amended, and Art. 2 and 3 of Government Decree No. 163/2002 Coll., as
amended by Government Decree No. 312/2005 Coll., and Government Decree No. 215/2016 Coll., its

CONSTRUCTION TECHNICAL CERTIFICATE

No. 060-047560

for product

Carbon reinforcement for concrete structures and road construction

Type / Variant:

HTC 10/15 - 40 POV, HTC 21/21 - 40, HTC 34/34 - 40, HTC 9/14 - 40

to manufacturer:

Alligard s.r.o.

ID No.: 25200933
Address: 44, 357 51 Libavské Údolí
Manufactory: **Alligard s.r.o.**
ID No.: 25200933
Address: 44, 357 51 Libavské Údolí
Contract: Z060170211

Through this construction technical certificate, Authorized Body 204 certifies the data on the technical characteristics of the product, its level and procedures for their collection in relation to the basic requirements set out in Annex 1 to Government Decree No. 163/2002 Coll., as amended by Government Decree No. 312/2005 Coll. and Government Decree No. 215/2016 Coll.

The certificate is a technical specification designed to assess the conformity of the specified product.

Number of pages of the construction technical certificate, including its front page: 3

This construction technical certificate has been produced by:

Ing. Márek Sopko
Lead assessor

Certificate expiration date: 31 October, 2021

Person responsible for the accuracy of this technical certification

Brno, 8 October, 2018

Ing. Miroslav Procházka

Deputy Director of Authorized Body 204

Warning: Without a written permission of the Authorized Body 204 Director, this Construction Technical Certificate may only be reproduced in its entirety.

Zdravotní ústav se sídlem v Ústí nad Labem
Centrum hygienických laboratoří
Pracoviště P1 Jana Černého 361/46, 503 41 Hradec Králové

Hradec Králové, 10 July 2018
Ref.: 48186/2018
Attention of: Ing. Hrnčířová

ALLIGARD s.r.o
357 51 Libavské Údolí 44

Subject: Investigation of the safety of products intended for direct contact with drinking water

On 17 July 2018, we received mesh samples; we examined the products and evaluated them according to Decree No. 409/2005 Coll., as amended.

As samples, you submitted:

48186 - carbon mesh with acrylic / styrene-butadiene coating
Manufacturer: ALLIGARD s.r.o., 357 51 Libavské Údolí 44

The scope of the investigation was set according to point no. 15 of Annex No. 1 to Decree No. 409/2005 Coll., which stipulates the minimum scope of set indicators for the individual groups of the most frequently used types of materials; we did rubber investigation. The scope of the investigation was expanded with determination of aluminium, chrome, nickel, arsenic and volatile organic compounds.

These nets shall be used as reinforcement for concrete products such as concrete tanks and pipes; they shall always be embedded in concrete and thus do come directly into contact with drinking water.

If cracks occur in the concrete product, local contact with drinking water may occur. Pursuant to Section 3(3) of Decree No. 409/2005 Coll., for a product that comes into direct contact with drinking water, whose surface area that comes into contact with the drinking water does not exceed 100 cm² or the ratio of whose area to the area of all other products in the water tank or in the water distribution network is less than 1:1000, or is less than 1:100 in the case an internal water conduit, by leach test done according to Annex No. 1 to the cited Decree, it is possible to at maximum to get the hygiene limit of the monitored drinking water indicator according to Decree No. 252/2004 Coll. The indicators not stipulated by Decree No. 252/2004 Coll., have a limit set in Section 3(6) of Decree No. 409/2005 Coll.

The product was evaluated according to point no. 12 B) of Annex No. 1 to Decree 409/2005 Coll., i.e. the resultant mean concentration of the migrated components is $K^{23}_{72.3}$.

Conclusion:

In the third leach, the product exhibited the value $CHSK_{Mn} = 3.45$ mg/1, Decree No. 409/2005 Coll., permits a value of $CHSK_{Mn} = 3.0$ mg/1 for short-term contact with water. In the rest of the indicators, the sample fulfilled the requirements of the cited decrees. Taking into account the fact that the product is intended for embedding as reinforcement in concrete products and comes into contact with drinking water only in case of disruption of the concrete layer, it can be stated that the effect on the water quality is minimal.

Ing. Jitka Hrnčířová
CHL P1 Hradec Králové

L.S.
(official stamp)

® TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague, SOE

Akreditovaná zkušební laboratoř, Autorizovaná osoba, Notifikovaná osoba, Oznamovaný subjekt, Subjekt pro technické posuzování, Certifikační orgán, Inspekční orgán •
Accredited Testing Laboratory, Authorized Body, Notified Body, Technical Assessment Body, Certification Body, Inspection Body • Prosecká 81/ 76a, 190 00 Praha 9 -
Prosek, Czech Republic

Authorised Body No. 204 according ÚNMZ Decision No. 5/ 2017
Branch Office 0600 - Brno

issues

pursuant to Act No. 22/1997 Coll., on technical requirements for products and on modification and amendment of some laws,
as amended, and Sections 2 and 3 of Government Regulation No. 163/2002 Coll., as amended by Government Regulation No.
312/2005 Coll., and Government Regulation No. 215/2016 Coll., issues

BUILDING TECHNICAL CERTIFICATE

No. 060-047196

for the product:

Basalt reinforcement for road construction

Type / variant: **HTB 10/ 14 - 40, HTB 22/ 22 - 40,**
HTB 36/36 - 40

Manufacturer:

Alligard s.r.o.

ID No.	25200933
Address:	Descriptive number 44, 357 51 Libavské Údolí
factory:	Alligard s.r.o.
ID No.	25200933
Address:	Descriptive number 44, 357 51 Libavské Údolí
Order:	Z060170211

Authorised Body 204 verifies by this Building Technical Certificate the data on the product's technical properties, their level and the procedures of their detection in relation to the basic requirements stated in Annex 1 of Government Regulation No. 163/2002 Coll., as amended by Government Regulation No. 312/2005 Coll., and Government Regulation No. 215/2016 Coll.

The certificate is the technical specification intended for assessing the conformity of a specified product.

Number of pages of the building technical certificate including the title page: 3

Processor of this building technical certificate:


Ing. Marek Sopko
Lead Assessor

Certificate validity: 31 August 2021 Person responsible for the correctness of this building technical certificate:

Brno, 10 August 2018




Ing. Jozef Póbiš
Head of authorised body 204

1. Description of the product and definition of its use in building construction:

The Basalt reinforcements for road construction are grids made of Basalt fibres, which are systematically layered using modified polymers, which have a tensile strength in the range 25 - 90 kN per 1 metre of width depending on the type of grid and direction of the fibre.

The Basalt reinforcement increases the tensile strength and bending stiffness of the asphalt-concrete structures of road and traffic surfaces and hence increases their service life. The reinforcement reduces the occurrence of cracks, which are caused by the dynamic effects of road traffic and voluminous temperature changes. The surface protection of the bundles of Basalt fibres improves the compatibility of the reinforcement with the asphalt.

Thanks to the flexible structure of the contact joints at the crossing of the bundles of basalt fibres, this reinforcement may be adapted to various aggregate grain sizes in the load-bearing and cover layer of asphalt-concrete and thus allow optimal bonding within and mutually between the individual layers. The position of the reinforcement is selected taking into consideration its assumed static function.

The Basalt reinforcement allows problem-free millability and recyclability of the worn layers, ensures better distribution of the load in the structure and its uniform settlement, and if designed properly, it also makes it possible to reduce the overall thickness of the load-bearing layers and is thus more economical in terms of consumption of resources.

Tab. 1: Specifications of the reinforcement

No.	Type	Mesh size - transverse/ longitudinal [mm]	Fibre type	
			Longitudinally	Transversely
1.	HTB 10/ 14-40	10/ 14	Basalt 2400 Tex, acrylic coating	
2.	HTB 22/ 22-40	22/ 22		
3.	HTB 36/ 36-40	36/ 36		

2. Definition of endpoints and method of assessment; Tab. 2:

Endpoints

No.	Monitored characteristic	Test Procedure	Number of samples		Required (P)/ declared level (D)
			C/ T	D	
1	Tensile strength over a width of 1 m	ISO 10406-1, chap. 6	10	5	D: H T B 10/ 14-40 WARP: min. 90 kN / m WEFT: min. 65 kN / m H T B 22/ 22-40 WARP: min. 40 kN / m WEFT: min. 40 kN / m H T B 36/ 36-40 WARP: min. 25 kN / m WEFT: min. 25 kN / m
2	Tensile Relative extension	ISO 10406-1, chap. 6	10	5	D: $f_{u,c}$ min. 650 MPa D: ϵ_u : 1.45% to 1.65%
3	Modulus of elasticity	ISO 10406-1, chap. 6.4.4	10	5	D: E: min. 55 GPa
4	Bonding strength of netting bundles	CSN EN ISO 15630-2	5	5	D: min. 15 N
5	Resistance to higher temperature	ISO 10406-1, chap. 6	10	5	D: Re \geq 80%: Conditioning at 200°C over a period of 6 hours D: Ret \geq 80%: Conditioning at 80°C over a period of 30 days
6	Resistance to freeze-thawing cycles under the action of de-icing salts	ISO 10406-1, chap. 6	10	5	D: Ret \geq 80% for 100 cycles -15°C, +20°C a bed of 3% NaCl solution
7	Reinforcement diameter	ISO 10406-1, chap. 5	3	3	D: tolerance -5% / +10%
8	Dimensional precision of the netting	CSN 42 0139	3	3	D: tolerance \pm 10%
9	Weight content of fibres	CSN EN ISO 1172	2	2	D: min. 80%
10	Cadmium content	Methodology No. 100611-01	1	1	D: max. 0.01%



Remark C - product certification (Section 5, 5a, 6, 10); T - validation/ assessment of product conformity (Section 7, 8)

3. Securing the production management system

General requirements for the production management system at the manufacturer are stated in Annex 3 to Government Regulation No. 163/2002 Coll., as amended.

4. Documents submitted by the manufacturer:

- Application for performance of the activities of Authorised Body 204, of 2 November 2017
- Technical data sheets for carbon reinforcements

5. Overview of the applied technical regulations, technical standards and other documents:

- Act No. 22/1997 Coll., on the technical requirements for products, as amended
- Government Regulation No. 163/2002 Coll., laying down the technical requirements for selected building products, as amended by Government Regulation No. 312/2005 Coll., and Government Regulation No. 215/2016 Coll.
- ISO 10406-1 Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
- ČSN EN ISO 15630-2 Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabrics
- ČSN 42 0139 Steel for the reinforcement of concrete – Weldable ribbed and plain reinforcing steel
- ČSN EN ISO 1172 Textile-glass-reinforced plastics -- Prepregs, moulding compounds and laminates -- Determination of the textile-glass and mineral-filler content -- Calcination method
- Methodology No. 100611-01 Determination of metals in a mineralizate sample: AAS - flame
- Technical manual 01.02.c Composite reinforcement on a base of glass or carbon fibres or their combinations
- Technical manual 01.02.a Welded fabrics made of ribbed and smooth wire

6. Validation tests:

No validation tests were done for the purposes of issue of the building technical certificate.

7. Detailed requirements for conformity assessment:

- The product is classified in Annex No. 2, Group 01, Item 2 pursuant to Government Regulation No. 163/2002 Coll., as amended and the prescribed method of conformance assessment corresponds to Section 5 of the given regulation. The manufacturer ensured maintenance of the production management system in compliance with the requirements of Section 5(1)(c) of the stated regulation.
- The supervision of the certified product shall be carried out once every 12 months.



® TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague, SOE

Akreditovaná zkušební laboratoř, Autorizovaná osoba, Notifikovaná osoba, Oznamovaný subjekt, Subjekt pro technické posuzování, Certifikační orgán, Inspekční orgán • Accredited Testing Laboratory, Authorized Body, Notified Body, Technical Assessment Body, Certification Body, Inspection Body • Prosecká 81/ 76a, 190 00 Praha 9 - Prosek, Czech Republic

Authorized Body No. 204
Decision of the ÚNMZ No. 5/ 2017 of 31 January 2017
Branch Office 0600 - Brno

PRODUCT CERTIFICATE

No. 204/ C5/ 2018/ 060-047236

In compliance with Section 5 of Government Regulation No. 163/ 2002 Coll., laying down the technical requirements for selected building products, as amended by Government Regulation No. 312/ 2005 Coll., and Government Regulation No. 215/ 2016 Coll., the authorised body acknowledges that for the building product

Basalt reinforcement for road construction

Type/ variant: HTB 10/ 14 - 40, HTB 22/ 22 - 40, HTB 36/ 36 - 40

Manufacturer:

Alligard s.r.o.

ID No.	25200933
Address:	Descriptive number 44, 357 51 Libavské údolí
factory:	Alligard s.r.o.
Address:	Descriptive number 44, 357 51 Libavské údolí
Order:	Z060170211

It reviewed the documents submitted by the manufacturer, performed the initial product type test on the sample, did the first audit at the production site, assessed the manufacturing process management method and ascertained that

- the given product complies with the requirements related to the essential requirements of the above mentioned Government Decree as stipulated in the Technical Approval:
STO No. 060-047196 of 10/ 08/ 2018 issued by Authorised Body No. 204 with validity up to 31/ 08/ 2021
- the system at the manufacturer complies with appropriate technical documentation and ensures that products placed on the market comply with the requirements set out in the above-stated technical certificate and the relevant technical documentation in accordance with Section 4(3) of the above-stated Government Regulation.

An integral part of this certificate is a Report on the Results of Certification No. 060-047220 of 14/ 08/ 2018, which contains the conclusions of the assessment, validation and test results and basic description of the certified product that is necessary for its identification.

This certificate was issued for the first time on 14/ 08/ 2018 and remains in force for the period over which the requirements stipulated in the building technical certificate to which reference is made or the manufacturing conditions at the manufacturing site or manufacturing management system shall not change significantly or as long as the Authorised Body does not change or cancel it.

The Authorized Body shall at least once every 12 months inspect the proper functioning of the production management system at the manufacturer, pick product samples at the place of production, perform tests of the product samples and assess whether the properties of the products correspond with the building technical certificate pursuant to the provisions of Section 5(4) of the above-stated Government Regulation. The Authorised Body shall issue a report on the assessment of the oversight that it shall provide to the manufacturer.

Person responsible for correctness of this certificate:



Brno, 14 August 2018

Ing. Miroslav Procházka
Deputy Head of Authorised Body 204

Zdravotní ústav se sídlem v Ústí nad Labem
Centrum hygienických laboratoří
Pracoviště P1 Jana Černého 361/46, 503 41 Hradec Králové

Hradec Králové, 10 July 2018
Ref.: 48184/2018
Attention of: Ing. Hrnčířová

ALLIGARD s.r.o.
357 51 Libavské Údolí 44

Subject: Investigation of the safety of products intended for direct contact with drinking water

On 17 July 2018, we received mesh samples; we examined the products and evaluated them according to Decree No. 409/2005 Coll., as amended.

As samples, you submitted:

48184 - basalt mesh with acrylic coating

Manufacturer: ALLIGARD s.r.o., 357 51 Libavské Údolí 44

The scope of the investigation was set according to point no. 15 of Annex No. 1 to Decree No. 409/2005 Coll., which stipulates the minimum scope of set indicators for the individual groups of the most frequently used types of materials; we did rubber investigation. The scope of the investigation was expanded with determination of aluminium, chrome, nickel, arsenic and volatile organic compounds.

These nets shall be used as reinforcement for concrete products such as concrete tanks and pipes; they shall always be embedded in concrete and thus do come directly into contact with drinking water.

If cracks occur in the concrete product, local contact with drinking water may occur. Pursuant to Section 3(3) of Decree No. 409/2005 Coll., for a product that comes into direct contact with drinking water, whose surface area that comes into contact with the drinking water does not exceed 100 cm² or the ratio of whose area to the area of all other products in the water tank or in the water distribution network is less than 1:1000, or is less than 1:100 in the case an internal water conduit, by leach test done according to Annex No. 1 to the cited Decree, it is possible to at maximum to get the hygiene limit of the monitored drinking water indicator according to Decree No. 252/2004 Coll. The indicators not stipulated by Decree No. 252/2004 Coll., have a limit set in Section 3(6) of Decree No. 409/2005 Coll.

The product was evaluated according to point no. 12 B) of Annex No. 1 to Decree 409/2005 Coll., i.e. the resultant mean concentration of the migrated components is $K^{23}_{72.3}$.

Conclusion:

The submitted sample **fulfilled** the requirements of Decree No. 409/2005 Coll., as amended and Decree No. 252/2004 Coll., as amended, for short-term contact with drinking water.

Ing. Jitka Hrnčířová
CHL P1 Hradec Králové

L.S.
(official stamp)