

**NovoCrete<sup>®</sup>**

Soil stabilization technology

**NovoCrete<sup>®</sup>**  
**soil stabilization technology**  
**ahead of its time**



## **Content**

**Initial situation**

**The solution**

**The result**

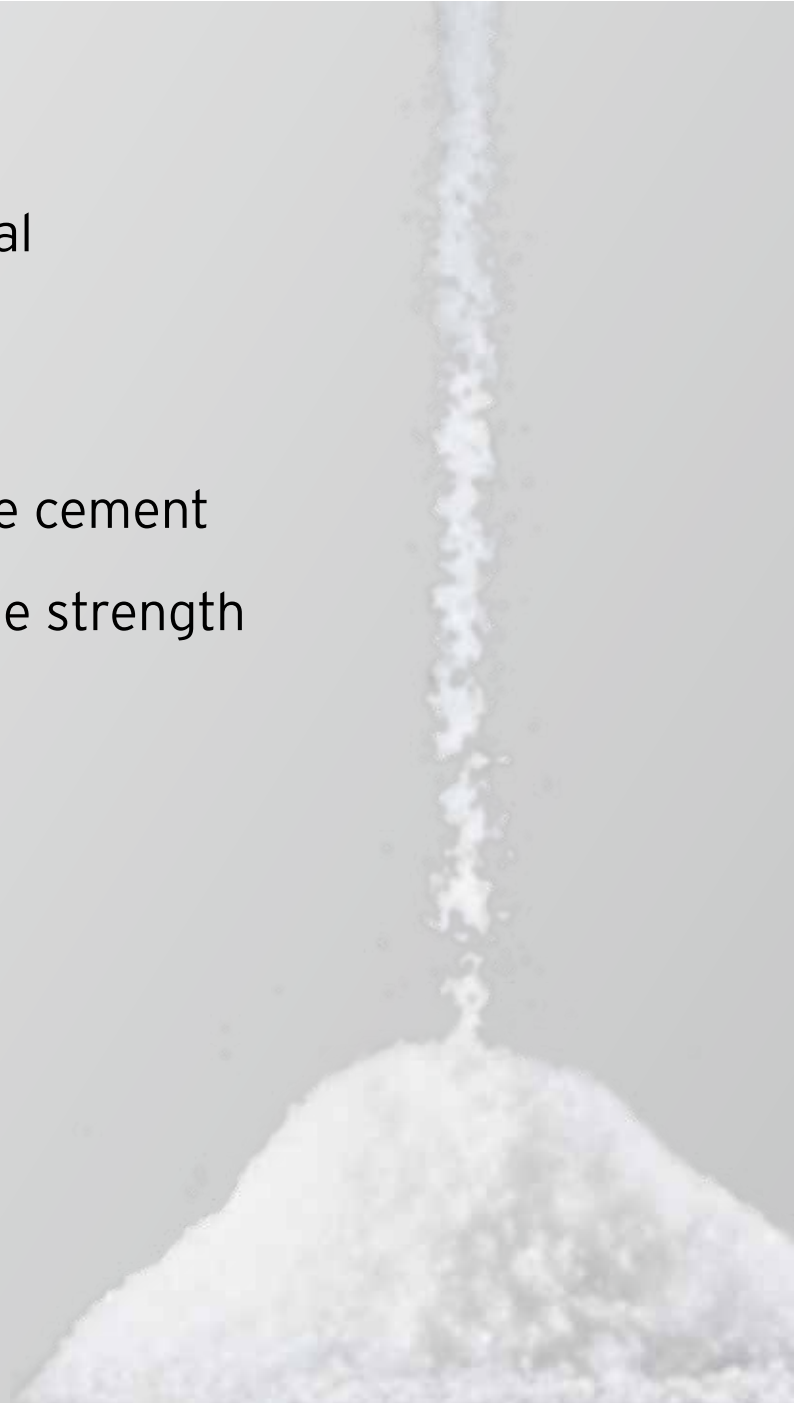
**10 arguments for NovoCrete<sup>®</sup>**

**Typical damages when using conventional technology**



## **The innovative NovoCrete® technology**

- › NovoCrete® is a white powder made from 100 % mineral components
- › Manufactured in Germany
- › Used as an additive to traditional Portland or composite cement
- › Provides higher load bearing capacity and higher tensile strength as well as an improved modulus of elasticity
- › PH levels will be neutralized and water impermeable layers can be built
- › Non-toxic and not harmful to health
- › Recyclable up to 100 %

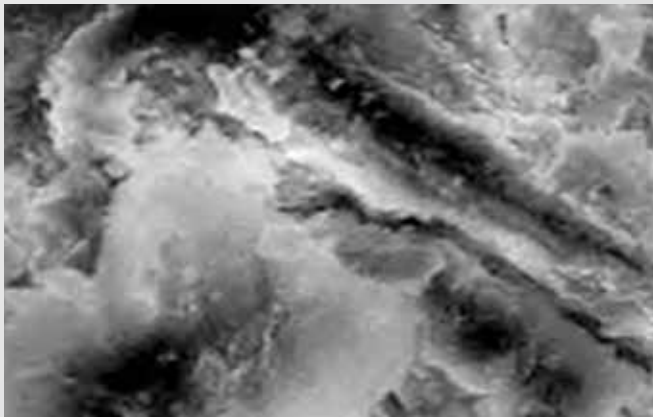


## Effectiveness

NovoCrete® is added to cement with a share of 2% and mixed together with the in-situ soil material.

By adding water NovoCrete® increases the formation of crystalline structures during the cement hydration process.

*Untreated cement:  
open pore structure*

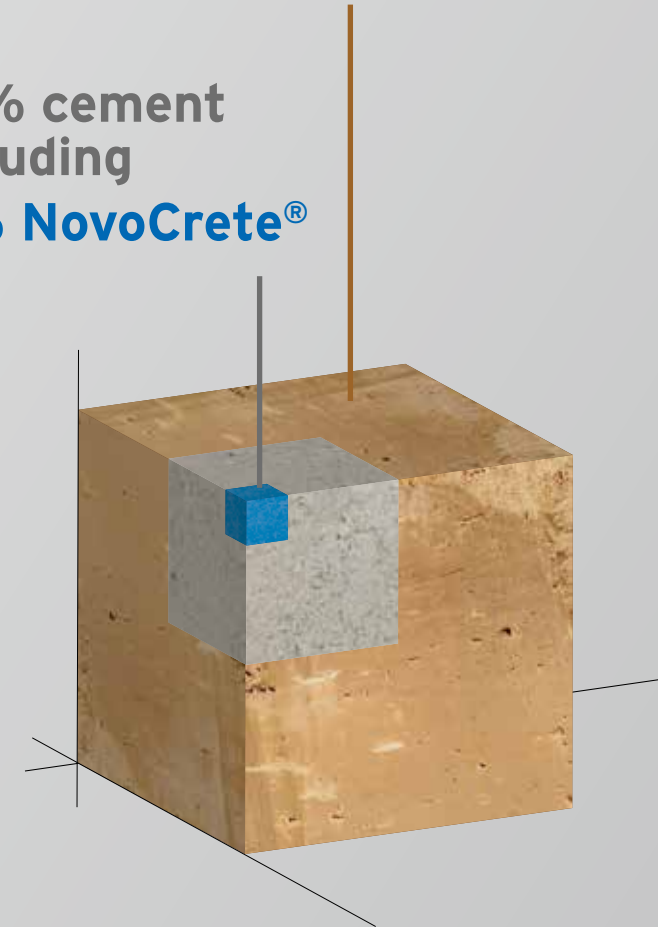


*Treated cement with NovoCrete®:  
closed dense structure*



**90% in-situ soil**

**10% cement  
including  
2% NovoCrete®**



**Perfect surface of the stabilized layer**



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**Argument no. 1**

**Manifold areas of use**

# 1. Broad Range of Applications





**Streets and Lanes**

- > road construction
- > motorway construction
- > footpaths
- > cycle paths
- > forest trails
- > agricultural roads
- > industrial access roads
- > verge stabilization
- > storage areas

**Areas**

- > installation of base courses underneath indoor surfaces
- > general foundation
- > car parks
- > container parking areas
- > logistics centres
- > harbour sites
- > wharves
- > storage areas for wood, metal etc.
- > bio-gas plants
- > silage storage areas
- > chaff storage
- > landfill sights

**Special applications**

- > railway tracks
- > tunnel and drainage system construction
- > slope stabilization
- > bank stabilization
- > slope reinforcement, grout
- > deep foundation replacement

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**Argument no. 2**

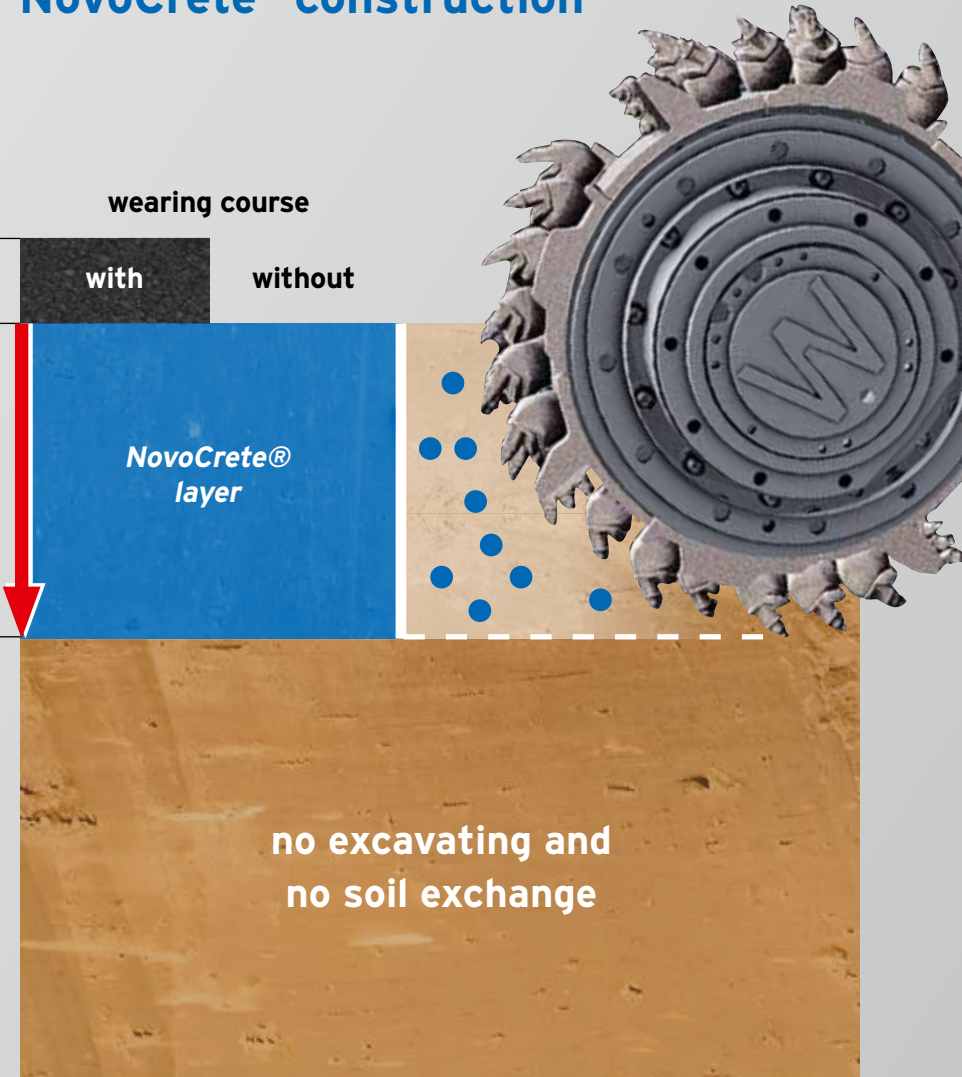
**Possible savings**

### Conventional soil stabilization vs. NovoCrete® comparison

#### Conventional construction



#### NovoCrete® construction



### Advantages at a glance

- › 90 day hydration process: next to no cracking with binder from up to 14%
- › During the hydration process, long crystal needles are formed, allowing very high bearing strengths
- › With a binder content of >10%, after 1 to 2 days values of at least 150 MN/m<sup>2</sup> can be attained, and can continue to increase for up to 90 days
- › The stabilized layers show low bending tensile strength.  
Concrete anchors may be installed
- › Water does not penetrate, nor any other fluid, into the stabilized layers, guaranteeing safety from frost
- › Low clean up costs at accidents involving leaked noxious matter, as liquids remain on the surface (no absorption)
- › Longer lifespan as it is water-resistant, and increased acid and salt resistance

## **Advantages at a glance**

- › Lifespan can be prolonged by laying a thin wearing course
- › No problems with loamy or clayey soils containing high levels of sulphur associated with high cement content
- › Grainy sands or organic material can be reinforced
- › Soils with high levels of salt can be stabilized
- › Stabilizing contaminated soils is possible
- › No problems from frost, thaw or changes in conditions, as water-resistant base courses may even be constructed from in-situ soils
- › Stabilization measures can be customised and adapted to particular soil conditions
- › Repair work can be significantly reduced
- › Restoration of surfaces to original condition is possible

**Example calculation Ø costs\*/m<sup>2</sup>**

| <b>Layers</b>                    | <b>conventional</b> | <b>NovoCrete®</b> |
|----------------------------------|---------------------|-------------------|
| asphalt surface layer            | 4 cm = XXXX €       | 8 cm = XXXX €     |
| binder course                    | 8 cm = XXXX €       | -                 |
| NovoCrete®-layer                 | -                   | 30 cm = XXXX €    |
| asphalt base course              | 12 cm = XXXX €      | -                 |
| base and frost protection course | 60 cm = XXXX €      | -                 |
| <b>total costs</b>               | <b>XXXXXX €</b>     | <b>XXXXXX €</b>   |

\*Costs always as a function of national / regional parameters

### With or without top layer



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**Argument no. 3**

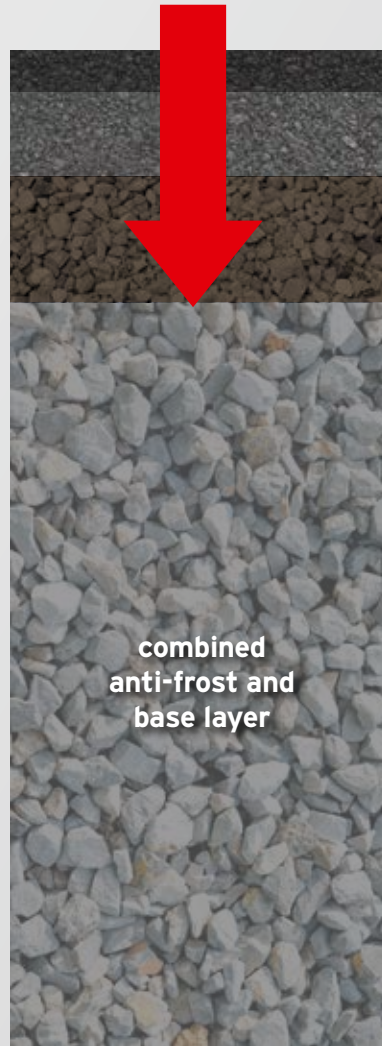
**High Heavy Load Capacity**



## Compared

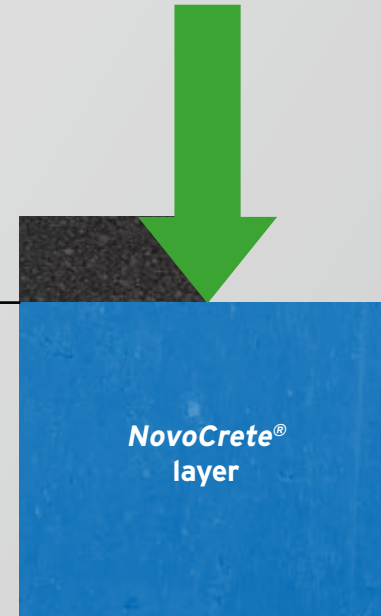
Conventional construction

**max. 150 MN/m<sup>2</sup>**

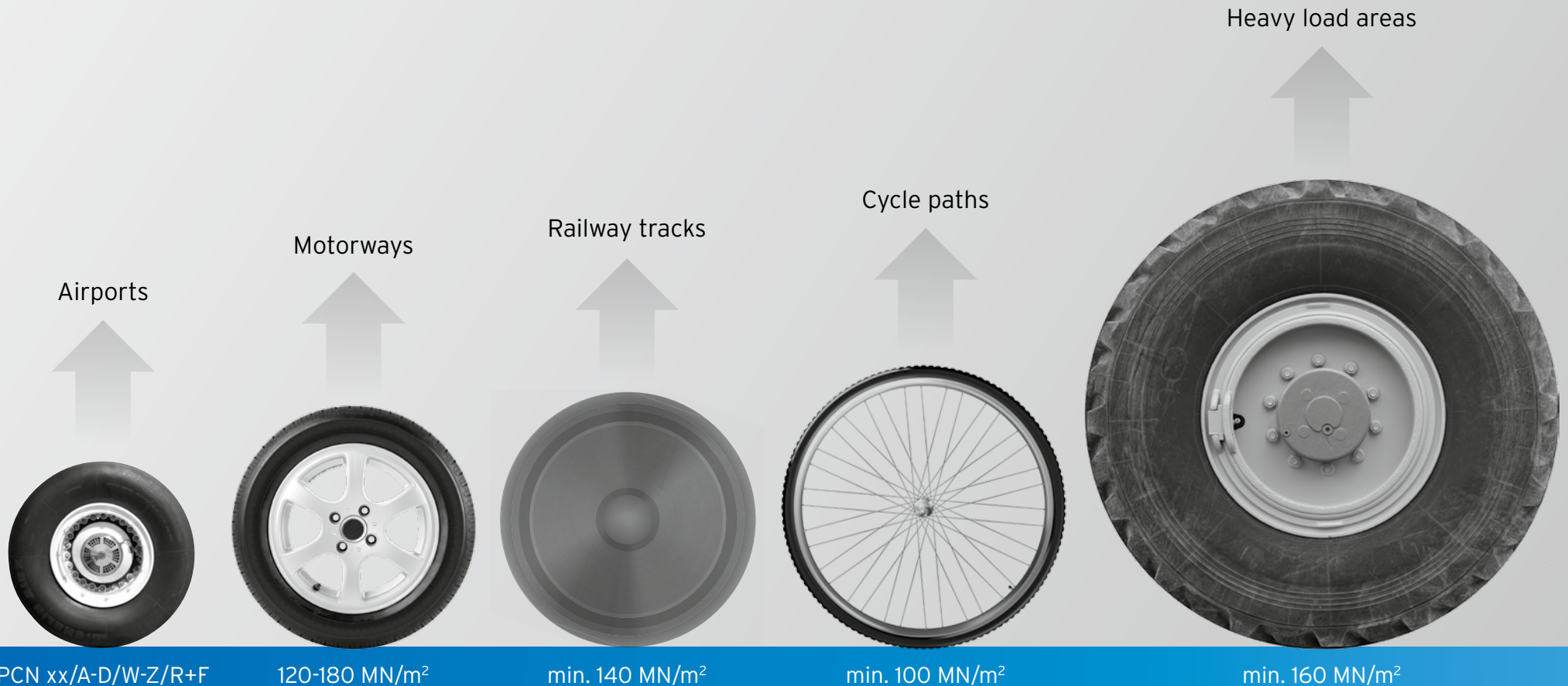


NovoCrete® construction

**> 150 MN/m<sup>2</sup>**



## Minimum bearing capacity to achieve (dependent on the project)



### 3. High Heavy Load Capacity

> 60t



> 40t



> 100t



> 50t

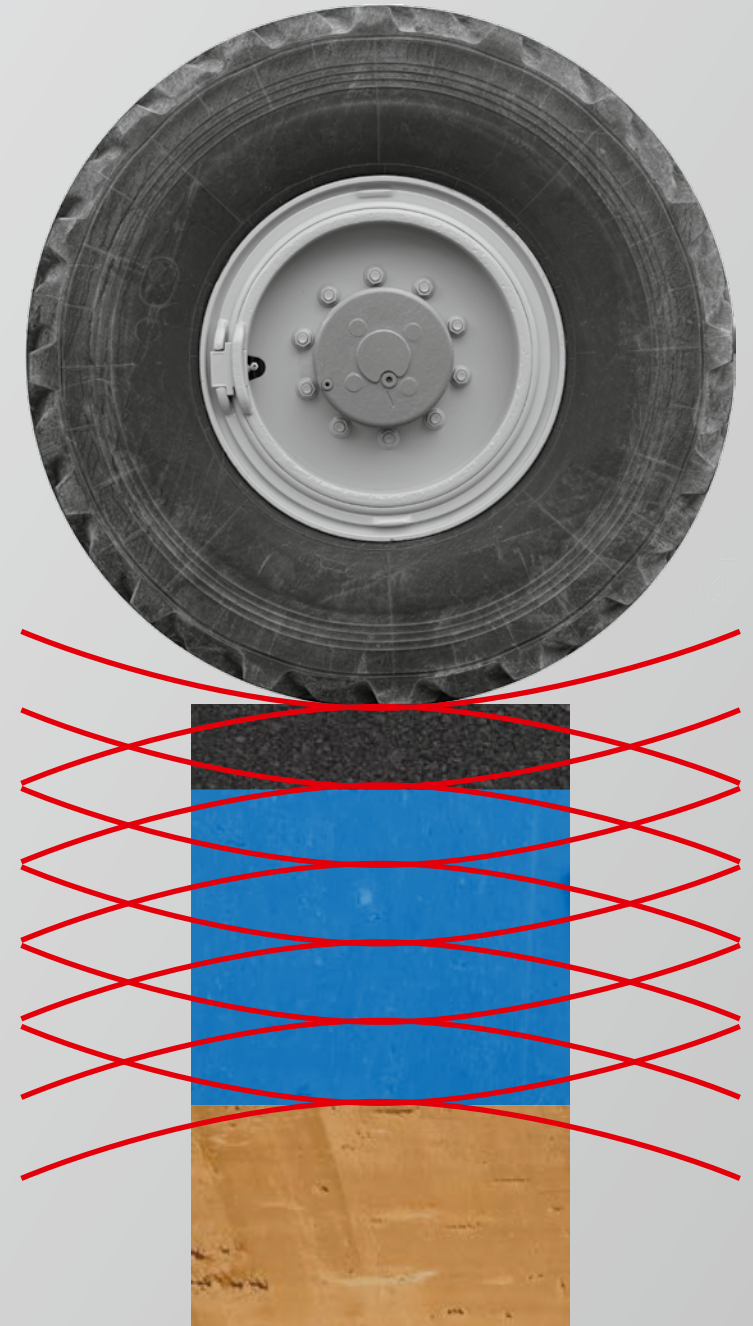


**Erection of concrete elements directly on the NovoCrete® layer**



#### High flexibility

The stabilized layers generate a very high tensile strength and a high flexibility which allows the absorption of vibrations e.g. caused by heavy truck traffic.



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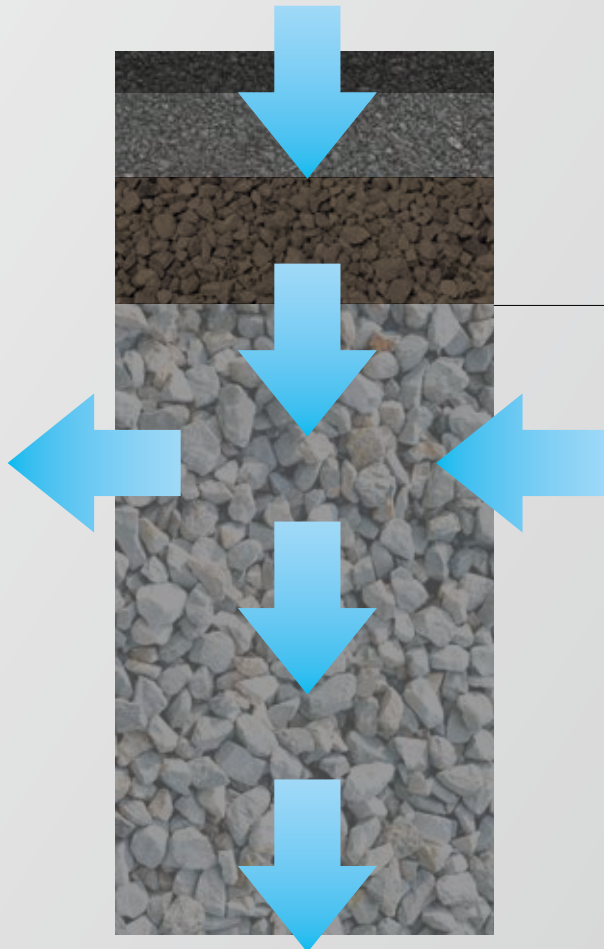
Soil stabilization technology

**Argument no. 4**

**Leak Proof Surfaces**

## Waterproof, increased acid and salt resistance

Conventional construction



NovoCrete® construction





**STOP!**



## Water impermeability depending on soil type

| <b>Soil type</b>   | <b>Amount of binding agent*</b>                              | <b>Milling depth</b> | <b>Water impermeability of the NovoCrete® layer</b>                                      |
|--|--|----------------------|--|
| wide-graded gravel<br>narrow-graded gravel<br>intermittently-graded gravel<br>wide-graded sand<br>narrow-graded sand<br>intermittently-graded sand | from<br>140 kg/m <sup>3</sup><br>to<br>180 kg/m <sup>3</sup> | 0,25 - 0,50 m        | 10 <sup>-6</sup> to 10 <sup>-9</sup> (m/s)   |
| gravel-silt mixture<br>gravel-clay mixture<br>sand-silt mixture<br>sand-clay mixture   | from<br>170 kg/m <sup>3</sup><br>to<br>200 kg/m <sup>3</sup> | 0,30 - 0,50 m        | 10 <sup>-6</sup> to 10 <sup>-9</sup> (m/s)<br>10 <sup>-7</sup> to 10 <sup>-9</sup> (m/s) |
| slightly plastic clay<br>slightly plastic silt<br>medium plastic silt<br>medium plastic clay<br>highly plastic clay                                | from<br>180 kg/m <sup>3</sup><br>to<br>220 kg/m <sup>3</sup> | 0,30 - 0,50 m        | 10 <sup>-8</sup> to < 10 <sup>-9</sup> (m/s)<br>< 10 <sup>-9</sup> (m/s)                 |

The final amount of binding agent and the milling depth must be determined for every project in dependance of the traffic volume, the climatic conditions, and the results of respective suitability tests.

\* Normally binding agent consists of 98 % standard cement + 2 % NovoCrete®

**waterproof = frost protection = no potholes**



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**Argument no. 5**

**Adaptable to  
most soil types**

## Adaptable to most soil types

- › Clayey, silty and sandy soils can be stabilized
- › Soils with a share of organic matter up to 15 % can be stabilized
- › Soils high in salt content can be stabilized
- › Suitable to stabilize and immobilize contaminated soils at the same time



## Amount of binding agent depending on soil type

| Soil type           |  | Initial water content  | Amount of binding agent *                           | Compressive strength N/mm <sup>2</sup> |
|---------------------|--|--|---|--|
| Non cohesive soils  | wide-graded gravel<br>narrow-graded gravel<br>intermittently-graded gravel<br>wide-graded sand<br>narrow-graded sand<br>intermittently-graded sand | from 0 to 10/15 %  | from 140 kg/m <sup>3</sup> to 180 kg/m <sup>3</sup> | 7 days - 28 days<br>from 3,0 to 9,0    |
| Mixed grained soils | gravel-silt mixture<br>gravel-clay mixture<br>sand-silt mixture<br>sand-clay mixture   | from 0 to 15/30 %  | from 170 kg/m <sup>3</sup> to 200 kg/m <sup>3</sup> | 7 days - 28 days<br>from 2,5 to 6,5    |
| Cohesive soils      | slightly plastic clay<br>slightly plastic silt<br>medium plastic silt<br>medium plastic clay<br>highly plastic clay                                | from 0 to 30/35/45 %   | from 180 kg/m <sup>3</sup> to 220 kg/m <sup>3</sup> | 7 days - 28 days<br>to 2,0 to 4,5      |
| Organic soils       | Mould<br>Organic clay<br>Organic silt  | In dependance of the results of respective suitability tests the NovoCrete® technology can be applied, maybe soil must be exchanged. |   |  |

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**Argument no. 6**

**Certified quality**

## **Digging, soil samples, suitability tests**

- › Geological expertise
- › Suitability tests
- › Laboratory examinations
- › Construction site survey



## Quality assurance

- › Creation of specimen on the site
- › Execution of a dynamic falling weight drop test
- › Testing by using a Troxler sonde
- › Execution of a static load plate bearing test





## Drill core analysis

**CONSULTEST AG**  
 Institut für Materialprüfung, Beratung und Qualitätsicherung im Bauwesen  
 STS 001

**Prüfbericht : Belagsaufbau**

Objekt: K304 Vorderwald - Murgenthal AO  
 km 0.091 - 2.176 (Vorderwald) und km 0.000 - 0.308 (Murgenthal)

Auftraggeber: Kanton Aargau : BVU / ATB  
 Überarbeitung: UH I / WB  
 Bauleitung: Ingenieurbüro Stauffer, Aarau  
 Unternehmer: STA Strassen- und Tiefbau AG, Olten

Probentyp: Bohrkern Ø 150 mm  
 Ort der Probenahme: siehe Tabelle  
 Probenahme durch: ConsulTest AG  
 Datum der Probenahme: 25.09.2009

Auftrag-Nr.:  
 Labor-Nr.:  
 Eingangsdatum:  
 Prüfdatum:

| Bohrkern-Nr.     | 1      | 2     | 3      | 4     | 5      |
|------------------|--------|-------|--------|-------|--------|
| Labor-Nr.        | 9762   | 9763  | 9764   | 9765  | 9766   |
| Profil [km]      | 1,060  | 1,120 | 1,180  | 1,240 | 1,300  |
| Abstand Rand [m] | rechts | links | rechts | links | rechts |
| SMA 11           | 36     | 28    | 40     | 33    | 40     |
| SAMI             | 8      | 6     | 0      | 8     | 8      |
| AC T 22 S        | 75     | 78    | 57     | 85    | 58     |
| Stabi            | 350    | 400   | 410    | -     | -      |
| Gesamtdicke [mm] | 469    | 512   | 515    | 126   | 106    |

Bemerkungen: - Datum / Unterschrift Sachbearbeiter: 12.10.2009

1310 PB, AG, V11.02

**CONSULTEST AG**  
 Institut für Materialprüfung, Beratung und Qualitätsicherung im Bauwesen  
 STS 001

**Prüfbericht : Bestimmung der Bohrkerndruckfestigkeit**  
 SN 642 503a

Objekt: K304 Vorderwald - Murgenthal AO  
 km 0.091 - 2.176 (Vorderwald) und km 0.000 - 0.308 (Murgenthal)

Auftraggeber: Kanton Aargau : BVU / ATB  
 Überarbeitung: UH I / WB  
 Bauleitung: Ingenieurbüro Stauffer, Aarau  
 Unternehmer: STA Strassen- und Tiefbau AG, Olten

Probentyp: Bohrkern Ø 150 mm  
 Ort der Probenahme: siehe Tabelle Belagsaufbau  
 Probenahme durch: ConsulTest AG  
 Datum der Probenahme: 25.09.2009

Auftrag-Nr.:  
 Labor-Nr.:  
 Eingangsdatum:  
 Prüfdatum:

| Proben-Bezeichnung | Labor-Nr. | Abmessung        |           |                | Rohdichte |       |
|--------------------|-----------|------------------|-----------|----------------|-----------|-------|
|                    |           | Durchmesser [mm] | Höhe [mm] | Verhältnis L/H | [kg/m³]   | [N]   |
| 1 oben             | 9762      | 148.0            | 147.0     | 1.0            | 2'305     | 186.4 |
| 1 unten            |           | 148.0            | 147.0     | 1.0            | 2'275     | 248.7 |
| 2 oben             | 9763      | 148.0            | 147.0     | 1.0            | 2'373     | 251.9 |
| 2 unten            |           | 148.0            | 146.0     | 1.0            | 2'279     | 185.2 |
| 3 oben             | 9764      | 148.0            | 146.0     | 1.0            | 2'260     | 145.3 |
| 3 unten            |           | 148.0            | 146.0     | 1.0            | 2'247     | 142.2 |
| Mittelwert         |           |                  |           |                | 2'290     |       |

Bemerkungen: - Datum/Unterschrift Sachbearbeiter: 12.10.2009

2111 PB, 104.07

**CONSULTEST AG**  
 Institut für Materialprüfung, Beratung und Qualitätsicherung im Bauwesen  
 STS 001

**Verdichtungskontrolle mit Troxler Isotopsonde**  
 SN 670 335a

Objekt: K304 Vorderwald - Murgenthal AO  
 km 0.091 - 2.176 (Vorderwald) und km 0.000 - 0.308 (Murgenthal)

Auftraggeber: Kanton Aargau : BVU / ATB / UH I / HV  
 Bauleitung: UH I / WB

Messdatum: 12.08.2009  
 Messstelle: siehe Tabelle  
 Messiefe: 0 - 20 cm  
 Material: anstehendes Material + Teerstabi + 54 kg/m³ DM

Departement Bau, Verkehr und Umwelt  
 Abteilung Tiefbau / Unterhalt  
 PS Belag + Geotechnik

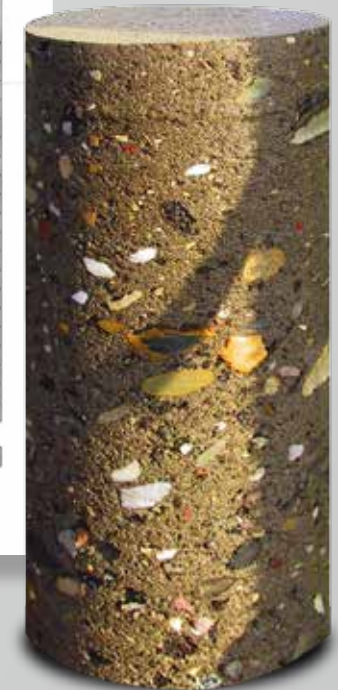
H<sub>2</sub>O-Gehalt: 5.7% [N] (Belwert)  
 Trockenschichte: 2334 kg/m³ (Belwert)

| Messpunkt  | Profil    | ab Achse | D feucht [kg/m³] | D trocken [kg/m³] | Wassergehalt [%] | Verdichtungsgrad [%] | Stützungsgang [%] |
|------------|-----------|----------|------------------|-------------------|------------------|----------------------|-------------------|
| 1          | 30        | x        | 2467             | 2327              | 6.0              | 99.7                 | 101               |
| 2          |           | x        | 2516             | 2352              | 6.5              | 101.2                | 123               |
| 3          | 30 + 15 m | x        | 2445             | 2208              | 6.4              | 98.5                 | 99                |
| 4          |           | x        | 2494             | 2337              | 6.7              | 100.1                | 117               |
| 5          | 31        | x        | 2383             | 2229              | 6.9              | 95.5                 | 88                |
| 6          |           | x        | 2385             | 2225              | 7.2              | 95.3                 | 91                |
| 7          | 31 + 15 m | x        | 2509             | 2345              | 7.0              | 100.5                | 125               |
| 8          |           | x        | 2469             | 2295              | 7.6              | 98.3                 | 116               |
| 9          | 32        | x        | 2457             | 2288              | 7.4              | 98.0                 | 111               |
| 10         |           | x        | 2448             | 2314              | 5.8              | 99.1                 | 94                |
| 11         | 32 + 15 m | x        | 2483             | 2325              | 6.8              | 99.6                 | 114               |
| 12         |           | x        | 2515             | 2350              | 7.0              | 100.7                | 127               |
| 13         | 33        | x        | 2457             | 2303              | 6.7              | 98.7                 | 105               |
| 14         |           | x        | 2392             | 2278              | 5.0              | 97.8                 | 73                |
| 15         | 33 + 15 m | x        | 2464             | 2284              | 7.9              | 97.8                 | 117               |
| 16         |           | x        | 2493             | 2321              | 7.4              | 99.5                 | 122               |
| 17         | 34        | x        | 2381             | 2244              | 6.1              | 96.1                 | 81                |
| 18         |           | x        | 2408             | 2300              | 4.7              | 96.5                 | 73                |
| 19         | 34 + 15 m | x        | 2368             | 2292              | 4.2              | 98.2                 | 84                |
| 20         |           | x        | 2433             | 2287              | 6.4              | 98.0                 | 98                |
| Mittelwert |           |          | 2449             | 2300              | 6.5              | 98.6                 | 101.8             |

\* gemäss Prüfbericht Praxtorversuch ConsulTest AG 412-09

Bemerkungen: - Datum: 23.08.2009 Unterschrift: M. Manig

531 PB, Version 8



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**Argument no. 7**

**Sustainability**

## Virtually no maintenance

- › Solid base layer = longer life span of the road
- › No potholes to fill
- › Formation of cracks in the asphalt layer is decisively reduced



**References on durability**

Unterlunkhofen 2013, built 2006



Alikon 2013, built 2006



Vordemwald 2013, built 2007



Remigen 2013, built 2007



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**Argument no. 8**

**Environment-friendliness**

## Advantages for the environment

- › No chemistry, only mineral components
- › Contaminated soils can be stabilized and immobilized in one procedure
- › Able to reclaim areas back to original state
- › No soil exchange material
- › No need for landfill sites
- › No gravel/aggregate material required
- › Less shipping volume and site-traffic
- › Without top layer it is possible to achieve an optical adjustment to the environment due to the similar color of the soil



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Soil stabilization technology

**Argument no. 9**

**Simple Application**

## Procedure steps

- Preliminary work**
- › Milling of the old asphalt layer
  - › Breaking up of old asphalt layer by using a Grubber (optional)
  - › Mixing of asphalt/gravel material by using a stone crusher (optional)
- 

- Stabilisation**
- › Spreading of binding agent by using a spreader vehicle
  - › Milling of cement-/NovoCrete® mixture
  - › Compaction with a steel drum roller (8 - 12 t)
  - › Preparation of the fine level by using a Grader
  - › Irrigation while milling and after compaction
- 

- Top layer**
- › Fitting-in of the new asphalt layer after 24 hours



**Milling of the old asphalt layer**



**Breaking the asphalt layer with a grubber (optional)**



**Crushing of asphalt/gravel material with a stone milling machine (optional)**



**Applying the binder with a spreader**



**Applying NovoCrete® with a mobile spreader**



**Milling of the cement/NovoCrete® mixture**



**Compression with a smooth drum roller (8-12t)**



**Creating the fine leveling with a grader**





**Watering while milling and after compression**



**Integration of the new asphalt layer already after 24 hours**



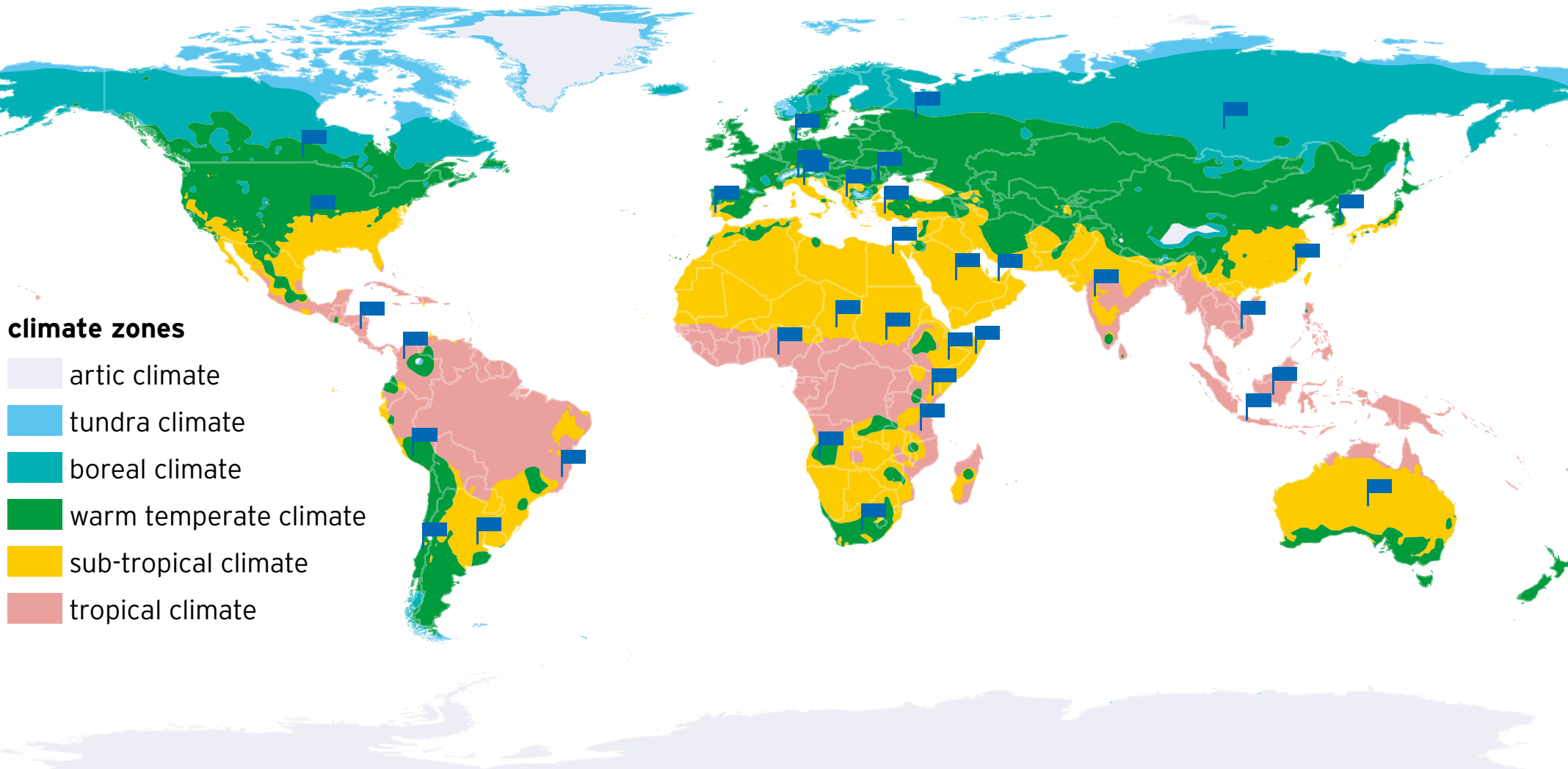
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**Argument no. 10**

**Worldwide acceptance**

**NovoCrete® - usage worldwide**



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Soil stabilization technology

**Thank you for  
your attention!**

[www.novocrete.com](http://www.novocrete.com)

**OPiS** AG

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