Concrete Pavement in Germany – Construction, Surface Texture, Interlayer, Drainage and Base Course

by Stefan Höller

Federal Highway Research Institute
(BASt / Germany)
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2. Concrete Pavement Construction
3. Concrete Pavement Surface Texture
4. Interlayers, Base Course and Drainage
5. Outlook
1. Introduction

2. Concrete Pavement Construction

3. Concrete Pavement Surface Texture

4. Interlayers, Base Course and Drainage

5. Outlook
<table>
<thead>
<tr>
<th>Autobahn</th>
<th>meistbefahrener Abschnitt</th>
<th>Verkehrsäte DTV [KZ/24h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Dresdern-Finkenhausen – Karlsruhe</td>
<td>186.100</td>
</tr>
<tr>
<td>3</td>
<td>Köln-Düsseldorf – Kreuz Köln-Ost (Northrhine-Westfalen)</td>
<td>157.100</td>
</tr>
<tr>
<td>8</td>
<td>Dresdern-Leimpert – Kreuz Stuttgart (Baden-Württemberg)</td>
<td>147.600</td>
</tr>
<tr>
<td>9</td>
<td>Kreuz München-Nord – Gerching-Süd (Bayern)</td>
<td>136.200</td>
</tr>
<tr>
<td>5</td>
<td>Frankfurt-Nord – Frankfurter Kreuz (Hessen)</td>
<td>145.900</td>
</tr>
<tr>
<td>7</td>
<td>Dresdern-Hamburg-Nord – Hamburg-Stellingen (Hamburg)</td>
<td>134.300</td>
</tr>
<tr>
<td>66</td>
<td>Frankfurt-Höchst – Eschborn – Dresdern (Hessen)</td>
<td>133.200</td>
</tr>
<tr>
<td>81</td>
<td>Ludwigsburg-Nord – Ludwigsburg-Süd (Baden-Württemberg)</td>
<td>129.300</td>
</tr>
<tr>
<td>2</td>
<td>Hannover-Horsenshausen – Dresdern Hannover-West (Niedersachsen)</td>
<td>129.000</td>
</tr>
<tr>
<td>99</td>
<td>Auehahn/FTW – Kirchen bei München (Bayern)</td>
<td>121.200</td>
</tr>
<tr>
<td>4</td>
<td>Kreuz Köln-Süd – Köln-Poll (Northrhine-Westfalen)</td>
<td>120.500</td>
</tr>
<tr>
<td>1</td>
<td>Kreuz Leverkusen-West – Köln-Nord (Northrhine-Westfalen)</td>
<td>119.400</td>
</tr>
<tr>
<td>57</td>
<td>Köln-Bickendorf – Köln-Longet (Northrhine-Westfalen)</td>
<td>118.500</td>
</tr>
<tr>
<td>40</td>
<td>Dresdern-Drum-Ost – Essen-Drum-Ost (Northrhine-Westfalen)</td>
<td>117.200</td>
</tr>
<tr>
<td>81</td>
<td>Offenbach-Kaiserslautern – Frankfurt-Ost (Hessen)</td>
<td>116.800</td>
</tr>
<tr>
<td>59</td>
<td>Dresdern-Sankt-Augustin-West – Dresdern-Bonn-Nordost (Northrhine-Westfalen)</td>
<td>115.900</td>
</tr>
<tr>
<td>116</td>
<td>Flughafen Tegel – Hackescher (Berlin)</td>
<td>114.700</td>
</tr>
<tr>
<td>52</td>
<td>Dresdern-Deitschord – Kreuz Deitschord (Northrhine-Westfalen)</td>
<td>111.700</td>
</tr>
<tr>
<td>46</td>
<td>Kreuz Hildesheim – Hildesheim (Northrhine-Westfalen)</td>
<td>111.600</td>
</tr>
<tr>
<td>565</td>
<td>Bonn-Beuel-Nord – Bonn-Beuelberg (Northrhine-Westfalen)</td>
<td>106.500</td>
</tr>
</tbody>
</table>

Road Network and Traffic in Germany
Climate in Germany

Summer Days
[Days min. + 25°C/Year]

Ice Days
[Days max. 0°C/Year]

Precipitation
[mm/m²/Year]
Why Concrete Pavement?

- High Durability
- Light Surface (Traffic Safety)
and
- National Raw Material
Content

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4. Interlayers, Base Course and Drainage

5. Outlook
Jointed Plain Concrete Pavement, (unreinforced slabs) JPCP
Concrete Mixing Plant

**Important:**

- Continuous Delivery of Cement and Aggregates
- Adequate Mixing Capacity
- Adequate Transport Capacity
- Short Distance to Construction Site
- Experienced Operators
## Concrete Pavement -
### Mix Design -

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength</td>
<td>Class C 30 N/mm² / 37 N/mm²</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>4.5 N/mm²</td>
</tr>
<tr>
<td>Aggregates</td>
<td>top layer: 0-8 mm; 0-16 mm; 0-22 mm</td>
</tr>
<tr>
<td></td>
<td>bottom layer: exposed aggregate only 0-8 mm</td>
</tr>
<tr>
<td></td>
<td>0-16 mm; 0-22 mm; 0-32 mm</td>
</tr>
<tr>
<td></td>
<td>layer thickness: min. 3 x aggregate size</td>
</tr>
<tr>
<td>Cement</td>
<td>Portland Cement (CEM I)</td>
</tr>
<tr>
<td></td>
<td>Composite Cement (CEM II) (Portland in combination with slag ashes, limestone, blast furnace)</td>
</tr>
<tr>
<td>Cement Content</td>
<td>min. 340 kg/m³</td>
</tr>
<tr>
<td></td>
<td>exposed aggregate: min. 420 kg/m³</td>
</tr>
<tr>
<td>W/C - Ratio</td>
<td>max. 0.45</td>
</tr>
<tr>
<td>Air Void Content</td>
<td>aggr. size 0-8mm: 5.50%</td>
</tr>
<tr>
<td></td>
<td>aggr. size 0-16mm: 4.50%</td>
</tr>
<tr>
<td></td>
<td>aggr. size 0-22mm: 4.00%</td>
</tr>
<tr>
<td></td>
<td>aggr. size 0-32mm: 4.00%</td>
</tr>
</tbody>
</table>
Examples of Slip Form Paver
Concrete Compaction by Poker Vibrator

Longitudinal

Concentration of Cement Paste and Fines => Cracks?

Transversal
## Construction Site

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td>+5°C - +25°C</td>
</tr>
<tr>
<td>Concrete Temperature</td>
<td>+5°C - +30°C</td>
</tr>
<tr>
<td>Higher / lower Temperatures:</td>
<td>special actions required</td>
</tr>
<tr>
<td></td>
<td>- heated Mixing Water</td>
</tr>
<tr>
<td></td>
<td>- heated Aggregates</td>
</tr>
<tr>
<td></td>
<td>- higher Cement Content</td>
</tr>
<tr>
<td>Curing</td>
<td>- Parafin Based Curing (early stage)</td>
</tr>
<tr>
<td></td>
<td>- Curing with Water (later on)</td>
</tr>
<tr>
<td></td>
<td>- Plastic Sheets / Tents (optional)</td>
</tr>
</tbody>
</table>
Concrete – Aluminium - Reaction

Fresh Concrete in Touch with Aluminium

=> Gas Decompression
Transport of Aggregates and Concrete to the Construction Site

Steel: Yes  
Aluminium: No
Variable Lane Width
Transportation of Slip Form Paver
„Manual Paving“ for smaller Sites
Dowels and Tie Bars
- Expansion Joints -

Positive:
- Position of Dowels and Tie Bars fixed by wooden inlays
- no influence of Compaction Energy on Position of Dowels and Tie Bars

Negative:
- Delivery of fresh Concrete limited
- Man Power intensive
Dowels and Tie Bars

- Contraction Joints / Baskets -

Positive:
- Position of Dowels and Tie Bars fixed by Baskets
- no influence of Compaction Energy on Position of Dowels and Tie Bars

Negative:
- Delivery of fresh Concrete limited
- Man Power intensive
Dowels and Tie Bars

- Contraction Joints / Installation by Vibration Devices -

Positive:
- Less Man Power
- Delivery of fresh Concrete not limited

Negative:
- Influence of Compaction Energy on Position of Dowels and Tie Bars

Position always correct?
Dowels and Tie Bars

- Requirements -

- Dowel Dimension
  25mm x 500mm

- Smooth Round Steel

- Plastic Coating 0.3 mm

- Tolerances:
  Horizontal Shift: +/- 50 mm
  Inclined Position: < 20 mm
  Vertical Shift: +/- 20 mm
Dowels and Tie Bars
- Position extremely wrong -

Damages appear quickly
Dowels and Tie Bars
- Measurement of Position -

Core Samples

Type of Measurement: destructive

effort: high

Quality of Result: high
Dowels and Tie Bars
- Measurement of Position -

Puls Induction Measurement

Type of Measurement: non destructive

effort: low

Quality of Result: medium

Measuring Device

Output of the Results
Dowels and Tie Bars
- Retrofit of Dowels -

Plastic-covered Dowel
Joint Sealant
Cut A - A

Concrete Pavement
Acrylic-based mortar
Dowels and Tie Bars
- Retrofit of Tie Bars -
Joints (longitudinal and transversal) - Saw Cutting -

Bevel Cutting

complete Transversal Joint

after 4 – 12 hours
Joints (longitudinal and transversal)
- Saw Cutting -

The right time?
Joints (longitudinal and transversal)

- Hot Bitumen Joint Sealing -

Construction

Winter

Summer

Primer

Application
Joints (longitudinal and transversal)
- Plastic Profile Joint Sealing -

Installation at any Weather Condition
Joints (longitudinal and transversal) - Plastic Profile Joint Sealing -

„Package Cracking“ in the Early Stage

Choose the right size!
Joints (longitudinal and transversal)
- Sealing of Expansion and Butt Joints -

Expansion Joint

Wooden Inlay

Butt Joint

1 bis 6 mm

Voranstrich
Fugenmasse
Fugeneinlage
Concrete Pavement

End Areas, to avoid horizontal Movements

Reinforced End Anchoir

Unreinforced „Double Concrete Slab“
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Concrete Pavement

Surface Texture (1938)

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1 cm
Traffic in Germany / Europe

Traffic Volume 1960

Traffic Volume 2010
Traffic in Germany / Europe

„Average“ Car in 1950

„Average“ Car in 2010
Concrete Pavement
Surface Textures (1972)

-Soft Brush - transversal -

1 cm
Concrete Pavement
Surface Textures for (1978)

- Steel Brush  - transversal -
Concrete Pavement

Surface Textures (1978)

- Hard Plastic Brush - longitudinal -
Concrete Pavement
Surface Textures (1991)
- Slipform Paver + Super Smoother -
+ Burlap - longitudinal
Concrete Pavement
Surface Textures
- Analysis of the Tyre – Road - Noise -
Concrete Pavement

Surface Textures
- Analysis of the Tyre – Road - Noise -

Microtexture
- < 0.001 mm
- high-frequency
- Adhesion
  - Negative: polished aggregates
  - Positive: Fine Structure and high skid resistance

Macrotexture
- 0.5 mm
- low frequency
- Noise Amplitude
  - Positive: roughness 0.4 - 0.8mm, cubic and sharp edge aggregates

Megatexture
- 50 mm
- noise Amplitude
  - Negative: uneven Surface
  - Positive: optimisation of construction

Wavelength
- 500 mm
Concrete Pavement

Surface Textures
- The Ideal -

Fine Microstructure
No Mechanical Stimulation of the Tyre

Medium Macrotexture (Gaps)
For Water Evacuation and Air Ventilation
Concrete Pavement

Surface Textures for (2000)

-Different Textures in Combinations,
-e.g.: Hard Plastic Brush + Tining - longitudinal -
Concrete Pavement

Surface Textures
- Grip and Texture Measurement -

Skid Resistance Tester (SRT)  Outflow Meter
Concrete Pavement

Surface Textures
- Grip and Texture Measurement

Measurement of Skid Resistance

Sideway Force Measurement
- high-speed measuring system
- skewed test wheel (20°) linear
- continuous data recording

Typical measuring set-up
Concrete Pavement
Surface Textures
- Grip and Texture Measurement -

Sand Patch Method

Volume of Gaps
Concrete Pavement

Surface Textures
- Grip and Texture Measurement -

- Microtextur: 0,001 mm
- Macrotexture: 0,5 mm
- Megatexture: 50 mm

Optical Texture Analysis
Streiflicht - Großes Messfeld
Laser Profilometer
Laser Measurement Vehicle

SEMÁNARIO INTERNACIONAL DE PAVIMENTOS DE HORMIGÓN
ICPA
## Concrete Pavement

### Surface Textures

#### - Grip Requirements -

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip (Construction Acceptance)</td>
<td>SCRIM</td>
</tr>
<tr>
<td>$\mu_{SRIM}$ (at 40 km/h)</td>
<td>0.56</td>
</tr>
<tr>
<td>$\mu_{SRIM}$ (at 60 km/h)</td>
<td>0.51</td>
</tr>
<tr>
<td>$\mu_{SRIM}$ at 80 km/h</td>
<td>0.46</td>
</tr>
</tbody>
</table>

**Alternative: SRT + Outflowmeter**

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRT</td>
<td>60 [-]</td>
</tr>
<tr>
<td>Outflowmeter</td>
<td>30 [s]</td>
</tr>
</tbody>
</table>

**Grip (End of Warranty, 5 Years)**

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_{SRIM}$ (at 40 km/h)</td>
<td>0.49</td>
</tr>
<tr>
<td>$\mu_{SRIM}$ (at 60 km/h)</td>
<td>0.45</td>
</tr>
<tr>
<td>$\mu_{SRIM}$ at 80 km/h</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Concrete Pavement

Surface Textures
- Noise Measurement -

Statistical Pass By (SPB), Currently only Individual Cars no Trucks
Concrete Pavement

Surface Textures
- Noise Measurement -

CPX Trailer Measurement, Currently only for Research
## Concrete Pavement
### Surface Textures
- **Noise Requirements**

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>SPB</td>
</tr>
<tr>
<td><strong>Reference Surface Texture:</strong></td>
<td></td>
</tr>
<tr>
<td>Ungrooved Mastic Asphalt</td>
<td>+/-0 dB (A)</td>
</tr>
<tr>
<td><strong>Concrete Pavement</strong></td>
<td></td>
</tr>
<tr>
<td>Wire Brush - transversal</td>
<td>+ 1 dB (A)</td>
</tr>
<tr>
<td>Exposed Aggregate</td>
<td>- 2 dB (A)</td>
</tr>
<tr>
<td><strong>Asphalt Pavement</strong></td>
<td></td>
</tr>
<tr>
<td>SMA</td>
<td>- 2 dB (A)</td>
</tr>
</tbody>
</table>
Concrete Pavement

Surface Textures
- Three Stages -

Cement Paste

Cement Paste and Sand

Cement Paste, Sand and Aggregates
Concrete Pavement
Surface Textures
- Exposed Aggregate -

Application of Retarder

Cover with Plastic Sheet
Concrete Pavement

Surface Textures
- Exposed Aggregate -

Application of Retarder and Curing Compound in Combination
Concrete Pavement

Surface Textures
- Exposed Aggregate -

Brushing the Mortar with Water / without Water

Saw Cutting the Joints
Concrete Pavement

Surface Textures
- Exposed Aggregate -

22 Peaks (25 cm²)
Noise Level (SPB) 84,7 dB(A)
inhomogen, noisy

52 Peaks (25 cm²)
Noise Level (SPB) 82,4 dB(A)
homogen, silent
Concrete Pavement

Surface Textures

„Manual for Concrete Pavement Surfaces Textures“

Version 2009

by FGSV, Köln
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Concrete Pavement
Interlayer, Base Courses and Drainage

Concrete Pavement

Non-Woven Fabrics

Hydraulically Bound Base Course

Frost Blanket Course

Concrete Pavement

Asphalt Base Course

Frost Blanket Course

Concrete Pavement

Crushed Gravel Base Course

Frost Blanket Course

5.0 m

Dowel Bars

Dowel Bars

Joint widths up to 4 mm

27

15

26

10

30

30
Concrete Pavement on Hydraulically Bound Base Course / Cement Treated Base Course
With An Interlayer of Non-Woven Geotextile

Concrete Pavement
Non-Woven Fabrics
Hydraulically Bound Base Course
Frost Blanket Course

27
15
Concrete Pavement on

Hydraulically Bound Base Course / Cement Treated Base with an Interlayer of Non-Woven Geotextile

**Before:** Concrete Pavement directly on hydraulically bond base course / cement treated base, Problems at the interface:

**In the Beginning:** Separation and Waterpumping

**Finally:** Erosion and Loss of Structural support
Concrete Pavement on
Hydraulically Bound Base Course / Cement Treated Base Course
With
An Interlayer of Non-Woven Geotextile
- History -
Concrete Pavement on Hydraulically Bound Base Course / Cement Treated Base with an Interlayer of Non-Woven Geotextile

- 3 Functions of the Nonwoven Geotextile Interlayer -

1. Separation

2. Elastic Bedding

3. Drainage
Concrete Pavement on

Hydraulically Bound Base Course / Cement Treated Base with an Interlayer of Non-Woven Geotextile

Cement Treated Base Course, mixed in place

Hydraulically Bound Base Course, mixed in plant
Concrete Pavement on
Hydraulically Bound Base Course / Cement Treated Base Course

- Requirements -

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Size</td>
<td>0-32 mm, 0-45 mm</td>
</tr>
<tr>
<td></td>
<td><em>(only Hydraulically Bound Base Course)</em></td>
</tr>
<tr>
<td>Fines (&lt; 0.063 mm)</td>
<td>max. 5 % by m.</td>
</tr>
<tr>
<td></td>
<td>=&gt;Frost test required</td>
</tr>
<tr>
<td>Cement Content</td>
<td>min. 3.0 % by m.</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>15 N/mm² (28 Days)</td>
</tr>
<tr>
<td>Layer Thickness</td>
<td>15 cm, 20 cm, 25 cm</td>
</tr>
<tr>
<td></td>
<td>+/- 3.0 cm</td>
</tr>
<tr>
<td>Compaction Degree</td>
<td>≥ 100 %</td>
</tr>
<tr>
<td>Eveness</td>
<td>&lt; 1.5 cm /4 m</td>
</tr>
<tr>
<td>Defined Surface</td>
<td>max. + 0.5 cm</td>
</tr>
<tr>
<td></td>
<td>min. - 1.5 cm</td>
</tr>
</tbody>
</table>

Grading Curve: only Hydraulically Bound Base Course
Installation of Non-Woven Geotextile

Concrete Pavement Surface on Non-woven Geotextile Interlayer

Semi-mechanical Installation of Non-woven Geotextile

Turning Points Outside the installed Non-woven Geotextile
Fixing of Non-Woven Geotextile

Fixing by washers $D=50\text{mm}$ and nails.
Non-Woven Geotextile manufactured with multicolor fibers: Completely Alkali Resistant?

Additives During manufacturing: 100% Polyolefine?
### Requirements for Non-Woven Geotextile -

#### for the Non-Woven Geotextile Product

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mas per Unit Area</td>
<td>450 g/m² ≤ mₐ,5% ≤ 550 g/m²</td>
</tr>
<tr>
<td>Thickness for Load of 2 / 20 / 200 kN/m²</td>
<td>d₂,5% ≥ 3 mm</td>
</tr>
<tr>
<td></td>
<td>d₂₀,5% ≥ 2,5 mm</td>
</tr>
<tr>
<td></td>
<td>d₂₀₀,5% ≥ 1 mm</td>
</tr>
<tr>
<td>Maximum Tensile Strength</td>
<td>Fₚₜ,5% ≥ 10 kN/m</td>
</tr>
<tr>
<td>Maximum Elongation</td>
<td>εₑₚₜₜ,5% ≤ 130 %</td>
</tr>
<tr>
<td>Water Permeability normal to the Plane at a Load of 20 kN/m²</td>
<td>kᵥ₂₀ₚₜ,5% ≥ 1 * 10⁻⁴ m/s</td>
</tr>
<tr>
<td>Drainage Capacity at a Plane at a Load of 20 / 200 kN/m²</td>
<td>kₕ₂₀ₚₜ,5% ≥ 5 * 10⁻⁴ m/s; kₕ₂₀₀ₚₜ,5% ≥ 2 * 10⁻⁴ m/s</td>
</tr>
<tr>
<td>Weather resistance</td>
<td>Residual Strength ≥ 60%</td>
</tr>
<tr>
<td>Alakali Resistance</td>
<td>min. 96% PP / PE</td>
</tr>
<tr>
<td>typ of Non-woven Geotextile</td>
<td>no Multi Color Products</td>
</tr>
</tbody>
</table>

#### for the Installation of the Interlayer

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>placement</td>
<td>tight without creasing</td>
</tr>
<tr>
<td>fixing</td>
<td>with nails and washers</td>
</tr>
<tr>
<td>overhang sideways</td>
<td>10cm +/-5cm</td>
</tr>
<tr>
<td>Overlap</td>
<td>20cm+/5cm</td>
</tr>
<tr>
<td>Quadruple overlaps</td>
<td>not Permissible</td>
</tr>
</tbody>
</table>
Trial applications in the USA

Test Section 1: Route D in Kansas City, Missouri (2008)
-Overlay technique–

(Overlay of a damaged concrete pavement with a concrete overlay)

Before: Asphalt interlayer

Now: Geotextile interlayer

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete overlay</td>
<td>12,7 cm</td>
<td>12,7 cm</td>
</tr>
<tr>
<td>Asphalt interlayer</td>
<td>2,54 cm</td>
<td>0,5 cm</td>
</tr>
<tr>
<td>Existing concrete</td>
<td>20,3 cm</td>
<td>20,3 cm</td>
</tr>
<tr>
<td>Base</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Trial applications in the USA

Test section 2: Interstate 40 in Warner, Oklahoma (2008)

- New construction (on cement-treated base) –

Concrete placement
Concrete Pavement

on hydraulically bond base course / cement treated base

with

an interlayer of Non-Woven Geotextile

- Recycling -

Possibilities of using RC-Aggregates

Concrete Pavement Surface

Nonwoven Geotextile Int.

Cement Treated Base

Frostprotection

Adhesion to the
Concrete Pavement
and the Base Course
Concrete Pavement with
Crushed Gravel Base Course

Concrete Pavement
Crushed Gravel Base Course
Frost Blanket Course
Concrete Pavement on Crushed Gravel Base Course - Research on the drainage behavior -

the idea

the reality
Concrete Pavement on Crushed Gravel Base Course
- Research on the Drainage Behaviour -

„Double-Ring“ Infiltration

- Diagram showing "Double-Ring" infiltration setup -

Unbound Base Course

Inner Ring
Outer Ring

Water Level
Concrete Pavement on Crushed Gravel Base Course

- Requirements -

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Size</td>
<td>0-32 mm, 0-45 mm, 0-56 mm</td>
</tr>
<tr>
<td>Fines</td>
<td>max. 5 % by m.</td>
</tr>
<tr>
<td>(&lt; 0.063 mm)</td>
<td></td>
</tr>
<tr>
<td>CBR-Value</td>
<td>≥ 80 %</td>
</tr>
<tr>
<td>Layer Thickness</td>
<td>30 cm, 20 cm, 25 cm +/- 3.0 cm</td>
</tr>
<tr>
<td>Compaction Degree</td>
<td>≥ 103 %</td>
</tr>
<tr>
<td>Deformation Modulus</td>
<td>$E_{v2} = 180 \text{ N/mm}^2$</td>
</tr>
<tr>
<td>Eveness</td>
<td>2.0 cm / 4 m</td>
</tr>
<tr>
<td>Defined Surface</td>
<td>max. +/- 2.0 cm</td>
</tr>
</tbody>
</table>
Concrete Pavement on
Crushed Gravel Base Course
- Construction Site -

Grader

Finisher
Concrete Pavement on
Crushed Gravel Base Course
- Traffic on Construction Site -
Concrete Pavement on
Crushed Gravel Base Course
- Recycling -
Concrete Pavement on Asphalt Base Course

Concrete Pavement

Asphalt Base Course

Frost Blanket Course
Concrete Pavement on
Asphalt Base Course
-Construction Site –

Finisher

Roller Compaction
Concrete Pavement on
Asphalt Base Course
-Requirements –

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>30/45; 50/70; 70/100</td>
</tr>
<tr>
<td>Grain Size</td>
<td>0-16 mm, 0-22 mm, 0-32 mm</td>
</tr>
<tr>
<td>Fines</td>
<td>max. 10 % by m.</td>
</tr>
<tr>
<td>Binder Content</td>
<td>min. 3.8 % by m.</td>
</tr>
<tr>
<td>Void Content</td>
<td>min. 4 % by v.</td>
</tr>
<tr>
<td></td>
<td>max. 10 % by v.</td>
</tr>
<tr>
<td>Layer thickness</td>
<td>10cm +/- 2.5cm</td>
</tr>
<tr>
<td>compaction degree</td>
<td>≥ 97 %</td>
</tr>
<tr>
<td>Eveness</td>
<td>max. 10 mm</td>
</tr>
<tr>
<td>Defined surface</td>
<td>max. + 0.5 cm; min. - 1.5 cm</td>
</tr>
</tbody>
</table>

Bild E 5: AC 22 T N
Content

1. Introduction
2. Concrete Pavement Construction
3. Concrete Pavement Surface Texture
4. Interlayers, Base Course and Drainage
5. Outlook
Concrete Pavement Innovations

-Poures Concrete –

Modified Asphalt Paver

Air Void Content 23 % b. vol.
Concrete Pavement Innovations

-Diamond Grinding –
Concrete Pavement Innovations

- Epoxy Coating with Chrome-Ore Slag –

Beschichten mit einer < 1 mm dünnen Epoxidharzschicht

Seminario Internacional de Pavimentos de Hormigón
Thank You for Your Kind Attention!

Questions?

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