Concrete Pavement Design and Construction in Germany
– State of the Art –
Stefan Höller
Content

1. The Historical Development
2. Standard Construction for Concrete Pavement
3. Maintenance of Concrete Pavement
4. Outlook and Innovation
Content

1. The Historical Development

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Concrete Pavement Surfaces in the 1930s

Concrete Pavement

Blinding Concrete

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Federal Highway Research Institute, (BASt, Germany)
Concrete Pavement Surfaces in the 1930s

Joint Spacing too far
Concrete Pavement Surfaces in the 1960s

Concrete Pavement
Hydraulically Bound Base Course
Frost Blanket Course

Concrete Pavement
Asphalt Base Course
Frost Blanket Course

Stefan Höller
Federal Highway Research Institute, (BASt, Germany)
Concrete Pavement Surfaces in the 1960s

Reinforcement of the individual Slabs by Steel Fabrics
Concrete Pavement Surfaces from 1980 to 2001

Mixed in plant

Mixed in place
Concrete Pavement Surfaces vom 1980 to 2001

Problems with Dowels in 1-Lift Concrete Pavement Surfaces
Concrete Pavement Surfaces vom 1980 to 2001
Concrete Pavement Surfaces from 1980 to 2001

Problems of Erosion and Water Pumping

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Federal Highway Research Institute, (BASt, Germany)
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Federal Republic of Germany

Population, Road-Network, Traffic

Inhabitants: 82,5 Mio.
Size: 357.046 km²
Density of population: 231 Inhab./km²

Motorways: 13,077 km
Concrete Pavement: ~3,500 km or 26.7 %
Federal Highways: 41,000 km

Traffic volume:
Motor vehicles: 55 Mio
on Motorways: 49,000 vehicles/day
peak volume: 189,000 vehicles/day
Federal Republic of Germany
Freight Transport

1997

- Railway: 63%
- Waterway Transport: 20%
- Road: 17%

2015 (Forecast)

- Railway: 83%
- Waterway Transport: 9%
- Road: 8%
Standard Constructions

Jointed Plain Concrete Pavement, (unreinforced slabs) JPCP

5.0 m

Jointwidths up to 4 mm

Dowel Bars

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
Concrete Pavement Surfaces

on Hydraulically Bond Base Course
With an Interlayer of Non-Woven Fabrics

Concrete Pavement

Non-Woven Fabrics

Hydraulically Bound Base Course

Frost Blanket Course
Concrete Pavement Surfaces on Asphalt Base Course
Concrete Pavement Surface on Crushed Gravel Base Course

Placement with Finisher or Grader

Drainage

Recycling

Stefan Höller
Federal Highway Research Institute, (BASt, Germany)
German Guidelines for Pavement Design („Standard Catalogue“)

For Asphalt Pavement, Concrete Pavement and Block Pavement

current version: 2001

revised version: 2013
## Traffic Load

<table>
<thead>
<tr>
<th>Construction Class</th>
<th>Equivalent 10to. axle load [Mio.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV</td>
<td>&gt; 32</td>
</tr>
<tr>
<td>I</td>
<td>10 – 32</td>
</tr>
<tr>
<td>II</td>
<td>3 – 10</td>
</tr>
<tr>
<td>III</td>
<td>0,8 – 3</td>
</tr>
<tr>
<td>IV</td>
<td>0,1 – 0,8</td>
</tr>
<tr>
<td>V</td>
<td>0,1-0,3</td>
</tr>
<tr>
<td>VI</td>
<td>&lt; 0,1</td>
</tr>
</tbody>
</table>

Service Life: 30 Years
Climate of Region

(Frost Zones I – III)

warm → cold

[ - degree Celsius * days]
## Classification of Sub Soil

<table>
<thead>
<tr>
<th>Class</th>
<th>Frost Sensitivity</th>
<th>Sub Soil Class according DIN 18196</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>not Frost sensitive</td>
<td>GW, GI, GE, SW, SI, SE</td>
</tr>
<tr>
<td>F2</td>
<td>minor to medium Frost Sensitive</td>
<td>TA, OT, OH, OK, (ST, GT, SU, GU)1</td>
</tr>
<tr>
<td>F3</td>
<td>very Frost sensitive</td>
<td>TL, TM, UL, UM, UA, OU, ST*, GT*, SU*, GU*</td>
</tr>
</tbody>
</table>

**Stefan Höller**
Federal Highway Research Institute, (BASt, Germany)
1.) Traffic Load
(equivalent 10 t Axle Loads)

2.) Climate of the Region
(Frost Zone I – III)

3.) Frost Sensitivity of Sub Soil
(F1-F3 Sub Soil)
Regulations for Concrete Pavement Surfaces

Testing Requirements

Construction Requirements

Material Requirements

Compressive Strength
Guidelines
for Individual Design of Concrete Pavement Surfaces

Splitting Tensile Strength

Testsection A94, Direction Munich, Splitting Tensile Strength - Compressive Strength

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Federal Highway Research Institute, (BASt, Germany)
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Repair and Renewal of Joints

Removing old Joint Sealant  Cleaning of the Joints  Re-cutting of Joints

Installation of backer rod  Re-Sealing of Joints

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Federal Highway Research Institute, (BASt, Germany)
Repair of Broken-Off-Corner with Polymer Concrete
Lifting and Securing of Slabs with Hydraulic Binder

Drilling of injection holes

Injection of Expansion Resin

Separating of slabs by means of compressed air

Grout

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Federal Highway Research Institute, (BASt, Germany)
Replacement of Slabs and Slab Sections

- Separating cuts
- Drilling machine for installation of tie-bars and dowels
- Prepared panel section
- Placing concrete
- Finishing
- Finished and well done

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Federal Highway Research Institute, (BASt, Germany)
Renewal of (single) Lanes

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Complete Renewal (Full-depth)

Placement of Dowel Bars
Regulations
for Maintenance and Rehabilitation of Concrete Pavement

„Manual“

„Requirements“

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Federal Highway Research Institute,
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Conciously Reinforced Concrete Pavement (CRCP)

with Asphalt Top Layer – (Composite Structure)
Concrete Pavement
„not only on Highways“
Fast Track Slab Replacement

- Saw-Cutting: 1 hour
- Crushing Dowel, Anchor: 1 hour
- Placing Concrete: 1 hour
- Hardening time: 23 hours
- Joints: 1 hour

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Federal Highway Research Institute,
(BASt, Germany)
Ultra-High-Performance Concrete

Overlay for fatigued and worn pavement (White Topping)
Recycling of damaged Concrete Slabs on Site and Reuse as RC-Aggregates

Stefan Höller
Federal Highway Research Institute, (BASt, Germany)
Thank You for Your Kind Attention!

Questions?

hoellers@bast.de