Growing Concerns in the US

- Aging highway system
- Heavier truck loads
- High maintenance costs

Solution

- Long-life concrete pavements that can provide a 40 to 50+ years of service life with only minimal inventions for M&R

Is the US concrete pavement technology optimized to meet the long-life needs?
Scan Objectives

Identify techniques used in other countries, and implementable in the US, for achieving longer-life concrete pavements

SCAN sponsored by: AASHTO, FHWA, NCHRP

SCAN Team Definition of Long-Life Pavements

Pavements optimized for a performance period in excess of 40 years, an extended time to first rehabilitation and minimal interventions for M & R activities. -- Per Bus Ride Discussion
Countries Visited
- Canada
- Germany
- Austria
- Belgium
- Netherlands
- United Kingdom

LLCP Team
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Areas of Interest
- Design
- Materials
- Construction
- Maintenance
Findings: Pavement Selection Strategies

- “Concrete pavement” means “long life”
- Public’s concerns (congestion, safety, environment/noise) influence pavement type selection

The Austrian Pavement Selection Scheme

- Design catalogs used in Austria, Belgium, and Germany
- Design lives of 30 years typically used; up to 50 years service expected
- Truck loadings are heavier than in US; super-singles are common

Catalog designs updated regularly - based on theoretical & lab studies, field experiments and performance observations
Findings: Pavement Design

- Full-width, full-depth concrete emergency lanes constructed for future capacity needs
- Widened slabs used to reduce concrete stress and deflection (as in the US)

Findings: Pavement Design

- Fewer tie bars used in longitudinal joints
- Smaller dowel bars (1-in-diameter) used
- JCP and CRCP built to same thickness (as in US)
- CRCP used for long life in Belgium - technology adopted from the US

Findings: Pavement Design

- Sealed and unsealed joints both perform well
- Bases: dense HMA and CTB; unstabilized bases also used
- 5 mm thick geotextile used to separate CTB and PCC in Germany
- Foundations are drainable, stable, protect against frost, and allow recycling of materials
Austrian Pavement Design
RVS 03.08.63

Type 5
Concrete
HMA
Unbound Base

Type 6
Concrete
HMA Layer
CTB

Load Classes

Freeways
Design Axle Load = 22,500 lb

Load Class S
Slab T = 10 in.
ESAL ≤ 40 Millions
Design Life = 30 Years

No distinction between "long life" and "normal life" for PCCP

German Standard Designs

<table>
<thead>
<tr>
<th>Construction class</th>
<th>Thickness of concrete pavement in cm</th>
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<tbody>
<tr>
<td></td>
<td>Hydraulically bound base course with geotextile</td>
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<tr>
<td>SV</td>
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<td>I</td>
<td>25</td>
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<td>II</td>
<td>24</td>
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<td>III</td>
<td>23</td>
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</tbody>
</table>
German Pavement Section

2. Standard concrete designs currently employed in Germany
Concrete pavement on a base course with hydraulic bonding and an intermediate layer comprising non-woven fabrics

- Installation
- Fixing

5 mm Geotextile over CTB

Belgium Highlights

Primarily use of CRCP – long-term experience

- 1970 to 1977
  - PCC t = 20 cm; Steel = 0.85%
- 1977 to 1991 (after US visit)
  - PCC t = 20 cm; Steel = 0.67%
- 1992 to 1995
  - PCC t = 23 cm; Steel = 0.72%
- Since 1995
  - PCC t = 23 cm; Steel = 0.76%

Basic US Section

Single layer construction

- 13 to 14 in.
- 6 in.
- 10 ft.

Concrete (sometimes well-graded)
Permeable base with edge drain
Granular filter layer
Subgrade stabilized
Findings

**Typical European Section**
(Thinner PCC thickness than in US)

- Top lift w/ exposed aggregate
- Bottom lift w/ recycled aggregates
- Emergency Lane
- Concrete (combined graded)
- HMAC or CTB (with AC/geotextile)
- Thick frost protection layer
- Subgrade

**Standard Features (Austrian)**

- Transverse contraction joint
- Longitudinal joint
- 9 cm sealed
- 25 cm dowel
- 6 cm asphalt
- 20 - 25 cm cement-stabilized
- 21 cm recycled concrete MA 32
- 6 cm exposed aggregate concrete MA 8 or 11

**Findings: Construction & Materials**

- Lower-alkali cements and blended cements used to mitigate ASR
- SCMs typically not considered in mixture proportions
- Attention to aggregate quality and gradation ... specially for top layer in two-lift construction
Findings: Construction and Materials

- Recycled concrete and recycled asphalt pavement used (or mandated) in lower layer in two-course construction
- Some countries use tiebars coated only in middle third

Findings: Construction and Materials

- Coated dowel bars used
- Intelligent compaction control used in Austria
- Small-plate proof testing of granular layers used in some countries
- Roughness measured with four-meter straightedge; excellent smoothness achieved

Concrete (RVS 85.06.32)

- Freeze-thaw resistant
- Flexural strength (28-days)
  - Bottom lift ≥ 800 psi
  - Top lift ≥ 1,000 psi
- Compressive strength (28-days)
  - Bottom lift ≥ 5,000 psi
  - Top lift ≥ 6,000 psi
- Well graded aggregates – 4 bins
- Two plants
  - Bottom lift concrete
  - Top lift concrete
Aggregate Bins

Recycling Concept for Concrete Motorways

Concrete Composition
RVS 88.06.32
Findings

**Top Lift Concrete Placement**
Fresh to fresh on bottom lift concrete

- Tie-bar placed by hand (right behind first paver)
- Dowels - placed automatically
- Densely compacted bottom lift – No sinkage
- Minimal surface finishing - longitudinal smoother
Drainage system (Austria)

Exposed Aggregate Surface

Step 1 - Curing compound + retarder
- water-repellent coefficient > 90 % (first 24 h)

Step 2 - Curing compound (applied after brushing)
- water-repellent coefficient > 85 %

Brushing Machine

Exposed aggregate surface
8 or 11 mm max size
Findings: Maintenance

- Typically, very little maintenance done on concrete pavements
- Little if any joint resealing done
- Ontario is field-testing precast slab techniques (similar to US) for rapid repair

Overall Highlights

- Standard designs - Stay with what works
  - Frost-free foundation & good base (HMAC/CTB)
- Standard materials
  - Higher strength concrete than in US
  - Blended cements more common, less SCMs
  - Upto 4 bins for concrete aggregate
  - Exposed aggregate surface – lower noise

Overall Highlights

- Good construction practices/QC
  - Good ride, even though no ride specs
    - They use straight-edge testing
  - Low paste surface (only 1 to 2 mm – brushed off)
  - Joint sawing with very little raveling
- Very careful approach to introducing new features/techniques

Design, materials and construction features need to be well integrated - no piecemeal improvements!
Possible US Implementation Items
High Payoff Items for Implementation

- Two-Lift Construction (as per 1992 SCAN)
  - Scarce quality aggregates for top lift only
  - Recycled/marginal aggregates in lower lift
- Design Features Catalog (1992 SCAN)
  - Standard design features for different types of roads
  - Highlight features necessary for long-life pavements
- High Quality Foundations
  - Minimize/eliminate frost & swelling
  - Basics - good pavements start with good foundations!

Possible US Implementation Items
High Payoff Items for Implementation

- Greater Attention to Concrete Mixture Proportions
  - Well graded aggregates/Dense mixture
  - Higher strength?
- Geotextile Interlayer
  - As interlayer instead of HMAC (for unbonded overlays)
  - Reduce overall section thickness
- Exposed Aggregates texture (1992 SCAN)
  - For noise reduction (additional evaluation needed)

US Implementation Champions?

- FHWA – provide leadership
- State DOT’s – provide projects
- Industry (ACPA) – lead innovations
- Academia – support innovations
- National Concrete Pavement Tech Center/ISU – support innovations
- AASHTO/TRB – support T2 efforts
Implementation Funding?
- Scan Program (limited funding)
- FHWA Highways For Life Program
- FHWA Concrete Pavement Earmarks
  - CPTP & Other
- NCPTC/ISU Earmark Funding
- Industry Initiatives
- State Pooled Funding for Specific Implementation Items

National Plans for Implementation
- Two-lift construction
  - Highways for Life program funding
  - Georgia, Kansas, Pennsylvania, Texas
  - Technical support: NCPTC/ISU
- Geotextile layer (as a bond-breaker for unbonded overlay)
  - Under discussion – Oklahoma DOT & Duit Construction

Thank You!

Obtaining Long-Life - Simply by Achieving Consistently What We Know is Attainable