LONG LIFE CONCRETE PAVEMENT SCAN TOUR - FINDINGS


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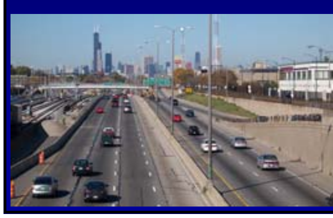
2007 Virginia Concrete Conference, Richmond, VA

Growing Concerns in the US

Aging highway system

Heavier truck loads

High maintenance costs

Congestion

Work zone safety

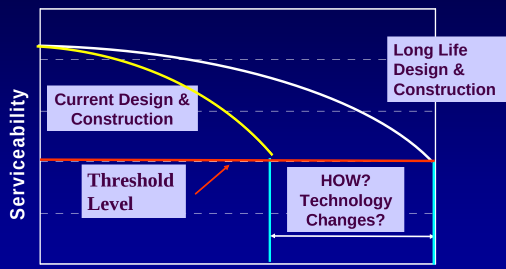
Noise

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?

Long-Life Expectations
(original surface)



-No out-of-the-box technologies in sight!!

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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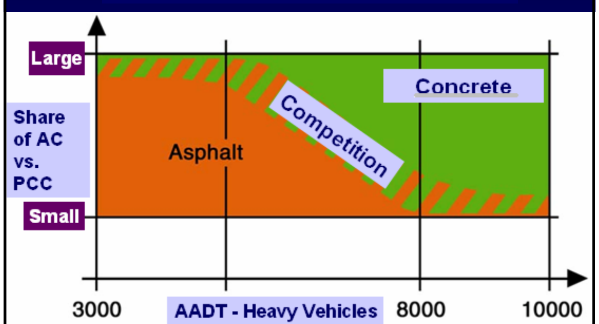
Areas of Interest

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



Findings: Pavement Design

- 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)

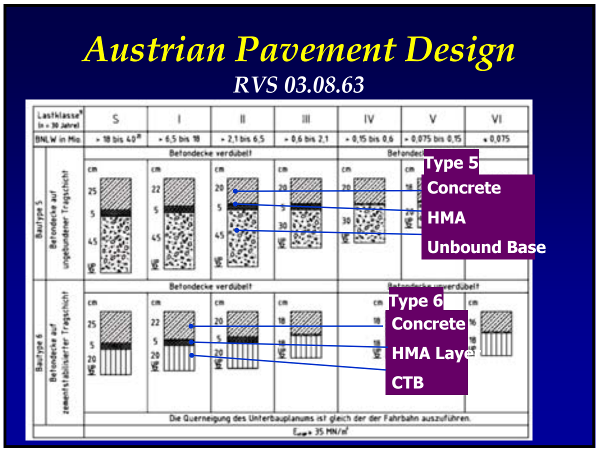
Findings: Pavement Design

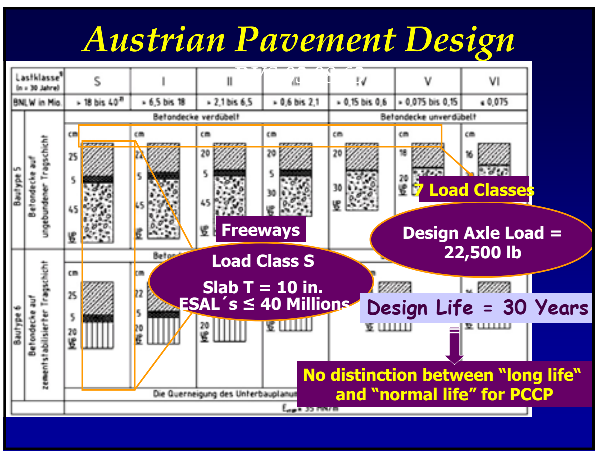
- Fewer tie bars used in longitudinal joints
- Smaller dowel bars (1-in-diameter) used
- JCP and CRCP built to same thickness (as in US)
- CRCP used for long life in Belgium - technology adopted from the US

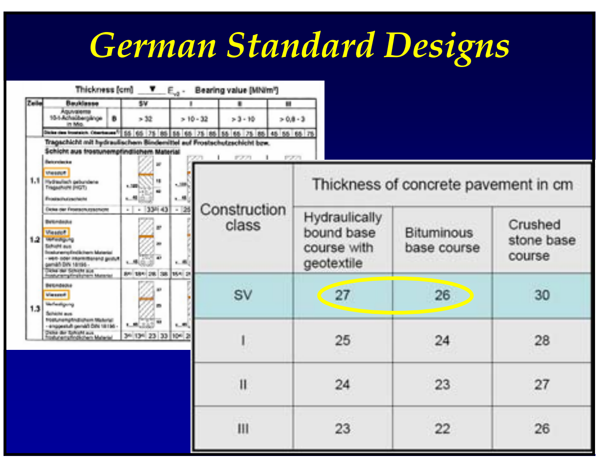
Belgian CRCP – close crack spacing - tight

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

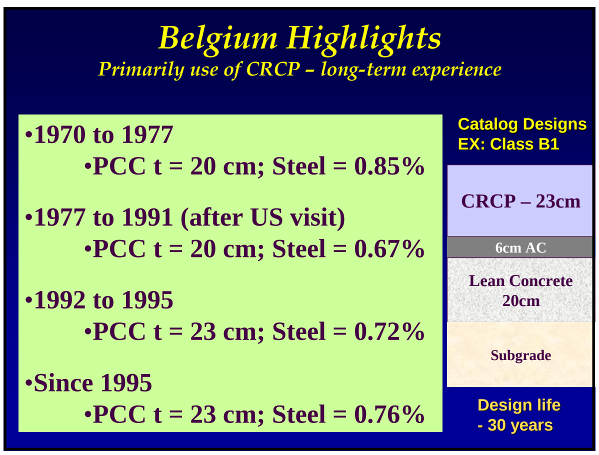


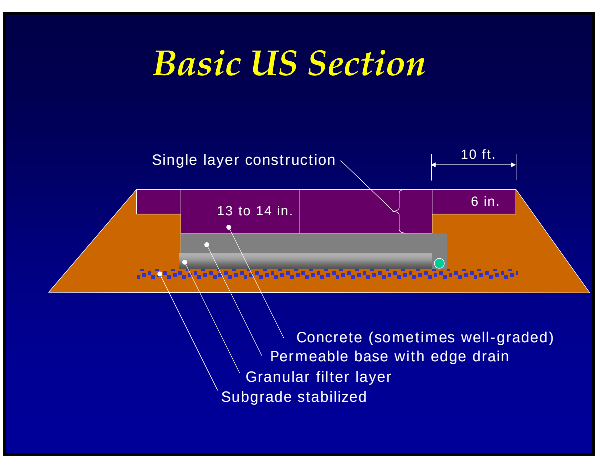




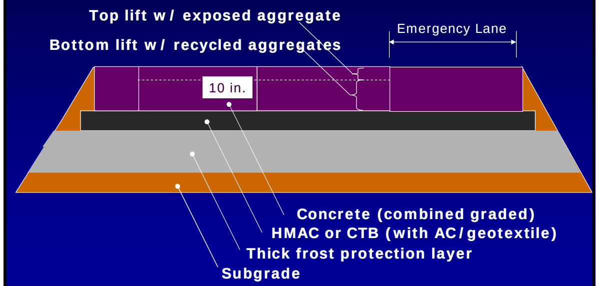
Construction class	Thickness of concrete pavement in cm: Hydraulically bound base course with geotextile	Bituminous base course	Crushed stone base course
SV	27	26	30
I	25	24	28
II	24	23	27
III	23	22	26


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
Concrete
CTB
Frost-free
27
15 / 20
45
5 mm Geotextile over CTB
bast

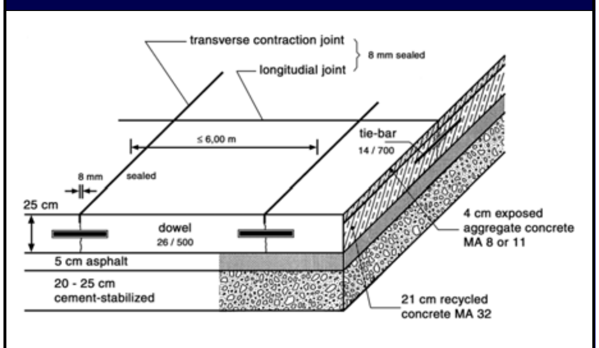

Belgium Highlights
Primarily use of CRCP – long-term experience
•1970 to 1977
•PCC t = 20 cm; Steel = 0.85%
•1977 to 1991 (after US visit)
•PCC t = 20 cm; Steel = 0.67%
•1992 to 1995
•PCC t = 23 cm; Steel = 0.72%
•Since 1995
•PCC t = 23 cm; Steel = 0.76%
Catalog Designs
EX: Class B1
CRCP – 23cm
6cm AC
Lean Concrete
20cm
Subgrade
Design life
- 30 years


Basic US Section
Single layer construction
10 ft.
13 to 14 in.
6 in.
Concrete (sometimes well-graded)
Permeable base with edge drain
Granular filter layer
Subgrade stabilized

Typical European Section
(Thinner PCC thickness than in US)



Standard Features (Austrian)



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

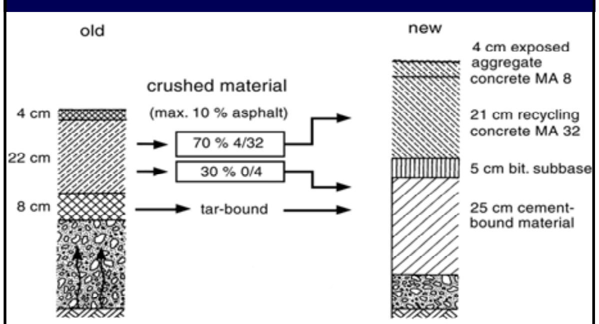
Concrete (RVS 8S.06.32)

- 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 aggragtes – 4 bins
- Two plants
  - Bottom lift concrete
  - Top lift concrete

Aggregate Bins

Recycling Concept for Concrete Motorways



Concrete Composition

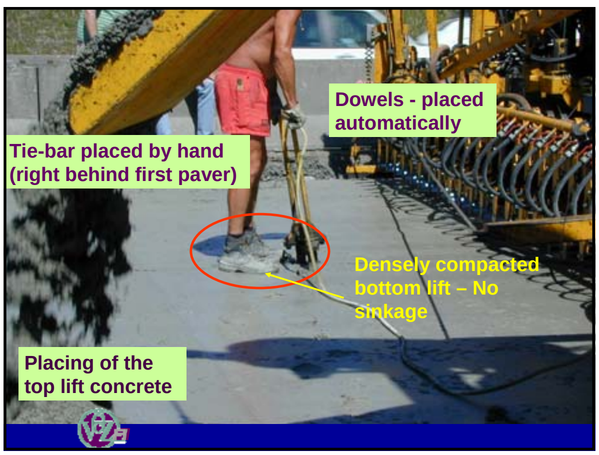
RVS 8S.06.32

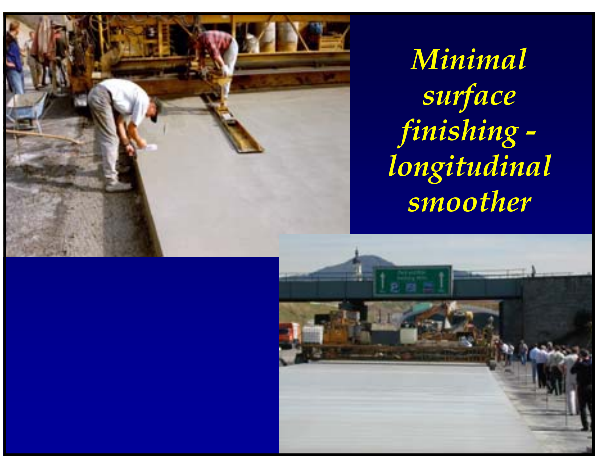
Method of paving	Standard values		
	Cement content kg/m³		Air content **) %
	Lower course	Upper course	
Fixed-form paving	320 *)	370	3.5 to 5.5
Slip-form paving	350 *)	400	4.0 to 6.0
Pavement-quality concrete with super-plasticizer	350 *)	400	
Exposed-aggregate concrete	As above *)	450	

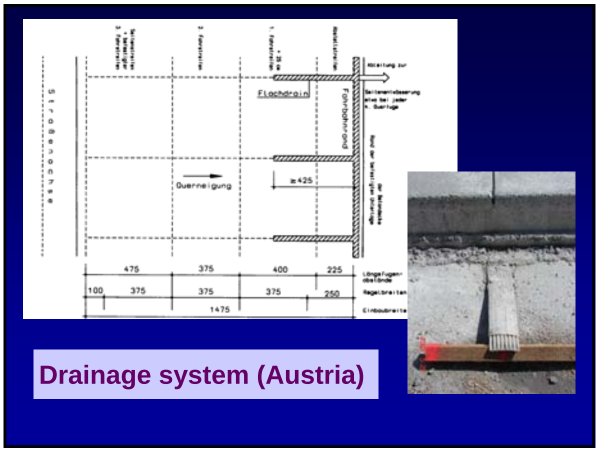
*) The target values for cement content shall be increased by 15 kg/m³ each when using mineral aggregate $C_{90/3}$ and recycled concrete material.
**) In the initial test and the conformity test.

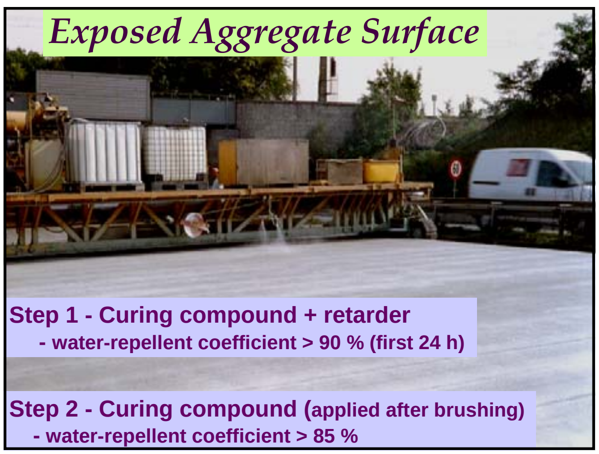
350 kg/m3 = 590 lb/cy; 400 kg/m3 = 674 lb/cy
450 kg/m3 = 758 lb/cy


Top Lift Concrete Placement
Fresh to fresh on bottom lift concrete


Dowels - placed automatically
Tie-bar placed by hand (right behind first paver)
Densely compacted bottom lift – No sinkage
Placing of the top lift concrete


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*