Creating Long Life Pavement Solutions
Continuously Reinforced Concrete Pavements

February 2012
CRSI – FHWA Workshop

FHWA – CRSI Cooperative Agreement

“Advancement of CRCP through Technology Transfer and Delivery of Industry Guidance for Design and Engineering”

- Design / Construction Manual
- Repair / Rehabilitation Manual (future)
- Newsletters, Website, and TT Bulletins
- Workshops
- Expert Task Group
Primary Message

• Continuously reinforced concrete pavement is a viable pavement option that provides long term pavement performance with low maintenance during its operational life at competitive whole life costs.
Long-Life Pavement*

- 40+ years of service
- No premature construction or material-related distresses
- Reduced or minimal cracking, faulting, spalling, punchouts
- Smoothness maintained
- Texture maintained

*Per FHWA in Long Life Initiatives Program*
CRCP - Long Life Pavement

- No man-made “joints”
- Steel reinforcement bars
- Numerous transverse cracks

**History**
- 1921 First used
- 1940’s Experimental Sections
- Today: More than 28,000 miles
CRCP Long Life Factors

• Excellent Performance History
  – TX, IL, OK, VA, GA, OR, BE, AU, UK
  – Problems identified and resolved

• Established design/construction practices

• Competitive whole life costs

• Minimal maintenance
CRCP Workshop Series

CRCP Expert Panel

– Industry, state, federal, academia

– Best Minds / New Minds

• IL, VA, TX, OR, OK, CA, GA

• CRSI, ACPA

• Tx A&M, TxTech, ISU, U of IL, Cleveland State

• ARA, Transtec
CRCP 101

ETG - What does the world think?

• Asphalt
  – Easier to build
  – Cheaper **
  – Easier to fix
  – Smoother / Quieter

• Concrete
  – Longer life
  – Whole life cost competitive
  – Heavy traffic
CRCP 101

CRCP Strengths

– Handles heavy duty, high volume traffic
  • Solution for increased freight loading
– Eliminates joints, leading to:
  • Less maintenance
  • Lower noise
  • Smoother over lifetime
– Exceptional foundation for overlays
CRCP 101

CRCP Strengths

• Competitive whole life cost
• Environmentally sustainable
• Reduces work zones and related safety impact
CRCP 101

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Solutions</th>
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<tr>
<td>• Too few CRCP States</td>
<td>• Teach and train</td>
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<tr>
<td>• Lack of Knowledge</td>
<td>• Learned from the past</td>
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<td>• Lingering Poor Long Performance</td>
<td>• Great performance now</td>
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<tr>
<td>• High initial costs</td>
<td>• Explain costs</td>
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<td></td>
<td>• Get out there!!</td>
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CRCP Workshop Series

• Engineers, Contractors, and Managers

• Green States – “we do it and believe in it.”

• Yellow States – “we need to revisit it.”

• Red States – “we are wide open to learn.”

• States on the Tour
  
  – **VA, LA, OK, AZ, OR, GA, CA**

  – Upper Midwest, Northeast and …
Today’s Workshop

• Objectives
  – To present CRCP details (easy-to-understand)
  – To stimulate CRCP discussion
  – To give adequate background to rethink CRCP
  – To solicit feedback on course and manual
Today’s Workshop

Workshop Program

• Pre-Workshop Discussions and Planning
• Opening Session: CRCP 101
• Caltrans: Where are we?
• Design: Methodologies, Practices, and ME PDG Guide
• Performance: Whole Life Costs
• Construction: Methods and Cautions, plus Traffic
• Repair and Maintenance: How to’s
• Unbonded Overlays: Rehabilitation Strategy for …. Today?
Today’s Workshop

A Word About the Manual

• www.crcpavement.org

• Unprecedented input from world’s best minds

• Virtual Manual
  – Continuous review
  – Continuous update
Today’s Workshop

CRCP 101
CRCP 101

Pavement Choices

• Asphalt
• Concrete
  – Jointed
  – Continuous
• Composites
CRCP 101
(Plain Jointed)

- Load Transfer: Aggregate Interlock
CRCP 101

(Jointed Concrete Pavement - w/Dowels)

- Combination of Load Transfer and Aggregate Interlock
CRCP 101

(Jointed Reinforced Concrete - Mesh)

• Rarely used in practice today
• Two-lift aspects is, however.
CRCP 101

(Jointed Concrete Pavement - w/Dowels)
CRCP 101

(Continuously Reinforced)

Crack Spacing
3-6 ft

Crack Width
.02 inches

*Highest Performer IF designed/built properly*
CRCP 101

CRCP - Typical

Longitudinal Joint

Crack Width .02 inches

Crack Spacing 3-6'

Steel Reinforcement

Base

Tie Bars

Subgrade
CRCP 101

- Asphalt “Carpet” over CRCP
- Concrete Overlay w/CRCP on Top

Unbonded  Whitetopping  Bonded
CRCP 101

Jointed Pavement Principle
• Concrete slab wants to crack
• Typically, transverse cracks occur from 12-20’
• Typically, transverse cracks open up about \( \frac{1}{8} - \frac{1}{2} '' \)
• Solution: Saw cut pavement BEFORE it cracks

CRC Pavement Principle
• Concrete slab wants to crack
• With steel, transverse crack spacing occurs (3-6’)
• With steel, transverse crack widths remain tight (.02’’)
• Solution: Let it happen!!
CRCP 101

Percent of Steel

0.6% - 0.8%

Almost Always

#5, #6, #7

Black Steel
CRCP 101

Tons of Steel

9" CRCP = 93 Tons per Lane Mile

10" CRCP = 104 Tons per Lane Mile

11" CRCP = 110 Tons per Lane Mile

12" CRCP = 118 Tons per Lane Mile

26-35 pounds per square yard

Note: 41-55 pounds of cement per sq yd

Note: 4-6 pounds of steel per sq yd jointed
CRCP 101

Design and Construction

- Design Procedure
- Concrete Materials
- Support System
- Steel Placement
- Concrete Placement
- Texturing and Cure
CRCP 101

Design

• Methods
  • AASHTO 86/93 Design Guide
  • IL, TX, CRSI, Belgium, etc
  • AASHTO 2007 MEPDG
  • Engineering Understanding!!

• Outputs
  • Subgrade and Base: Thickness, Strength
  • Slab: Thickness, Strength, CTE
  • Steel: Steel Ratio, Crack Spacing and Width
  • Performance: Time to Distress
  • Costs: Initial and Whole Life Costs
CRCP 101

Materials

Cement + Water + Aggregates + Supplementary Cementitious Materials + Additives (optional) = Concrete

CRCP 101

CRCP Coefficient of Thermal Expansion

CRCP Normal
CRCP 101
Support System

CRCP Normal Asphalt Aggregate
CRCP 101
Steel Placement
60', Bundled
No Kinks/Bends
CRCP 101
Steel Placement

Single Layer

Double Layer

CRCP Unique
CRCP 101

Steel Placement

Bar Splices

End Restraint
CRCP 101
Concrete Placement
Transport
Placement
CRCP Normal
CRCP Normal
Transport
CRCP 101
Concrete Placement

Consolidation

Finishing
CRCP 101
Concrete Placement

Texturing

Curing

CRCP Normal

CRCP Normal
CRCP 101
Concrete Placement

Construction Joints

End Treatment
CRCP 101

• Early Performance

  – Cracks form within 24 – 72 hours (60%) and gradually for up to a year (100%).
  
  – Some times you see them.
  
  – Sometimes you don’t.
  
  – Very hard to measure.
CRCP 101

- Long Term Performance

- Non-uniform crack patterns are detrimental and common

- They lead to spalling and punchouts

*Generally do not occur on today’s CRCP pavements*
CRCP Repair
CRCP 101

Keys to Success

• Non-erodible subbase
• Good drainage
• Widened lanes
• Tied shoulders
• Proper thickness
• Proper steel amount
• Proper steel placement
• Good construction practices

Results

• Proper crack spacing
• Proper crack width
• Smooth
• Durable
CRCP 101

At the end of the day, will you agree?

– CRCP can carry heavier loads than alternates.
– CRCP can last longer than jointed concrete and asphalt.
– CRCP has been studied extensively, with problems resolved.
– CRCP is a whole cost value.
– CRCP is a smooth, quiet option.
– CRCP is excellent for composite construction
– CRCP is a long term sustainable solution.
– CRCP technical assistance is now available.
CRCP 101

• Continuously reinforced concrete pavement is a *viable pavement option* that provides long term pavement performance with low maintenance during its operational life at competitive whole life costs.