Driving Innovation: Portland Cement Concrete (PCC) Overlays

US 58 Concrete Overlay Open House

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Franklin, Virginia

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Presentation Overview

- Why Concrete Overlays
- Types of Concrete Overlays
- What's Being Built On Route 58?
- Concrete Overlay Technology Transfer
- Some Recent Innovations
- Summary

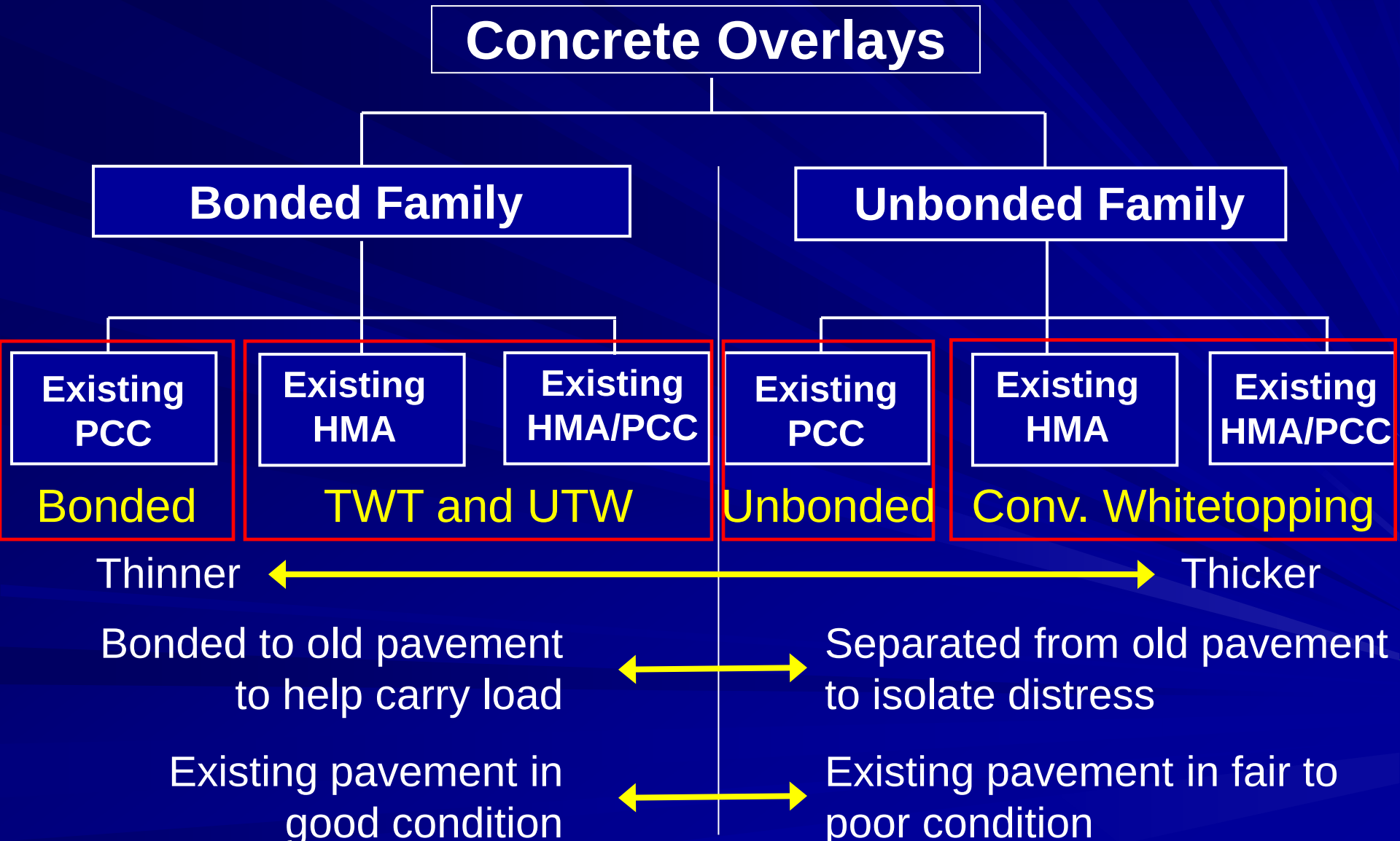
Why Concrete Overlays?

- Long performance lives
- Low maintenance requirements
- Sustains heavy truck loadings
- Low life-cycle costs
- Versatile
- Sustainability considerations

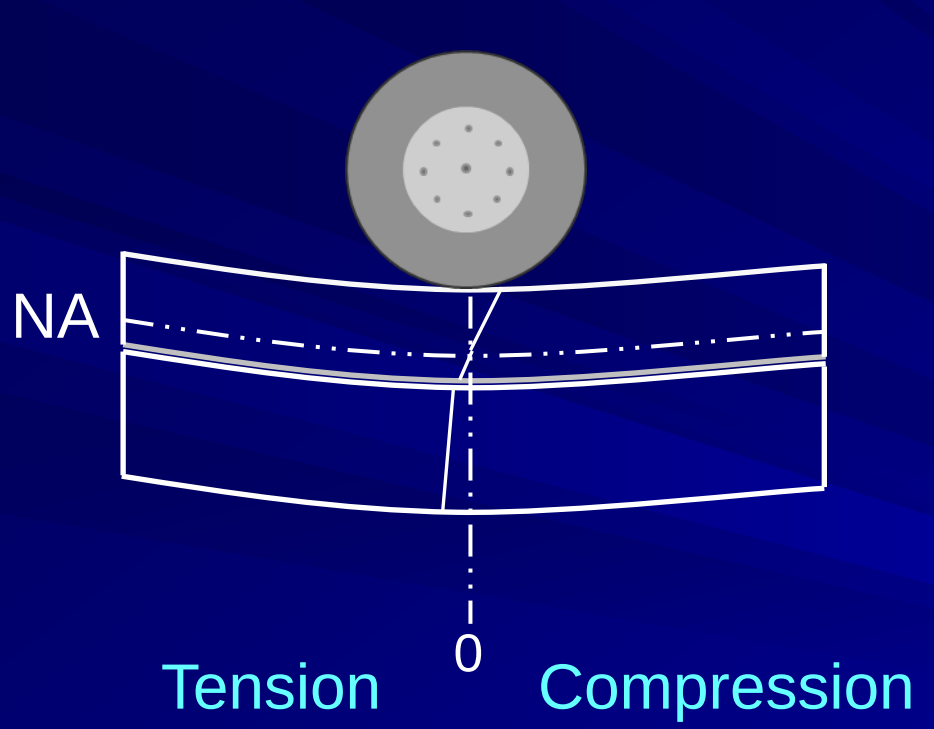
Types of Concrete Overlays

- On Existing Portland Cement Concrete (PCC) Pavements
  - Bonded PCC overlays
  - Unbonded PCC overlays
- On Existing Hot-Mix Asphalt (HMA) Pavements
  - Bonded PCC Overlays (aka, thin and ultra-thin whitetopping
  - Unbonded PCC overlays (aka, conventional whitetopping)

Concrete Overlay Families

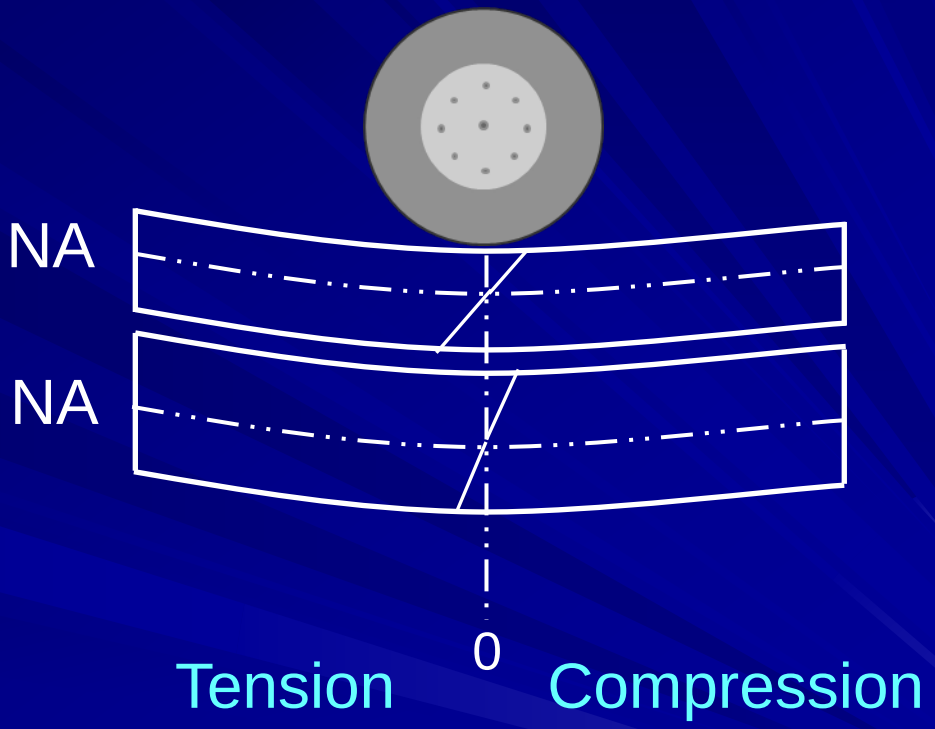


Overlay Interface Bonding



Bonded

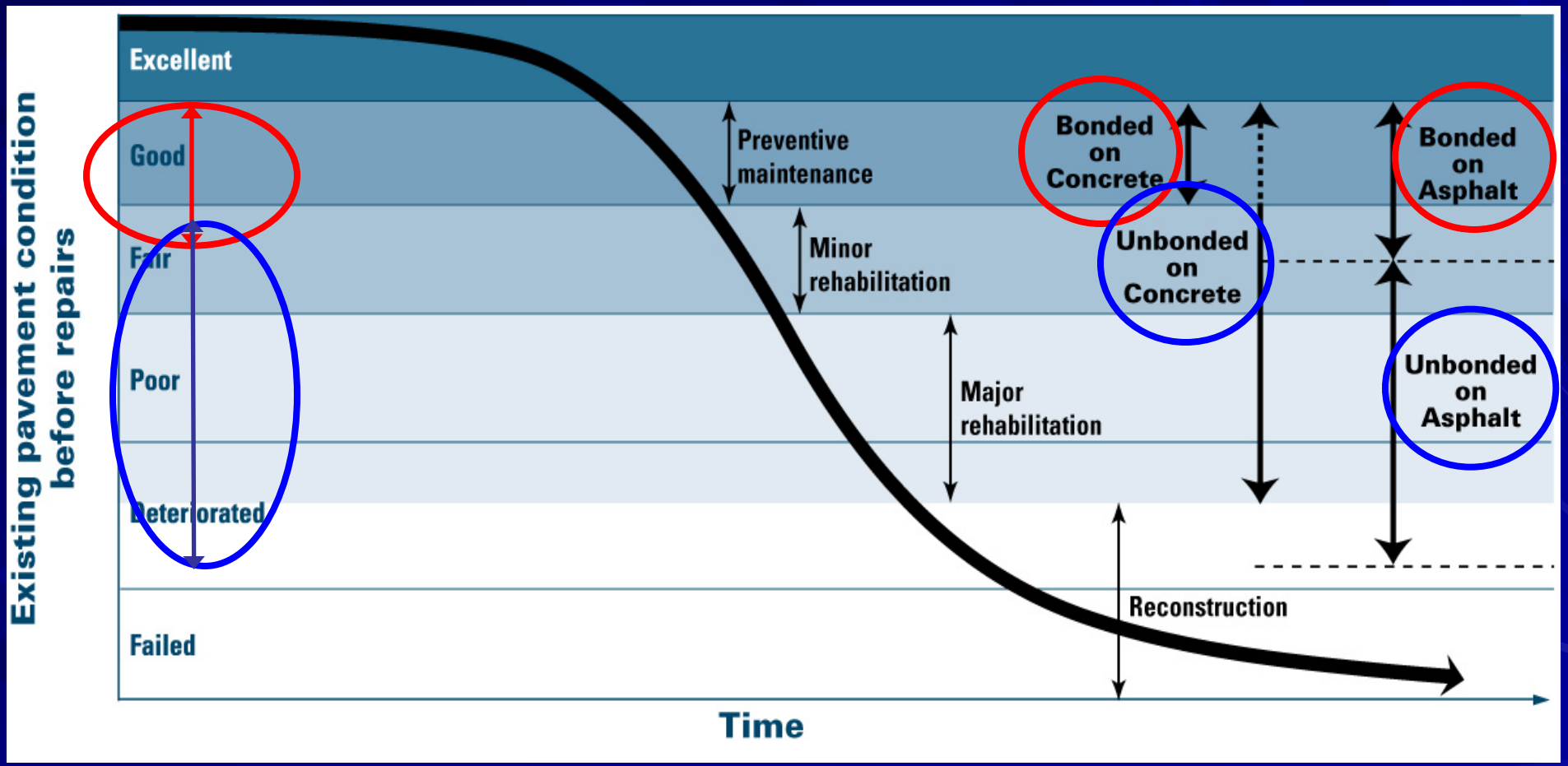
Two layers approach single-slab behavior



Unbonded

Two layers act independently from one another

General Applicability of Concrete Overlays



Nationwide Experience

- Technology dates back nearly 100 years
- Favorable performance under a range of conditions (e.g., CO, IA, IL, KS, MI, MN, MO, OK, PA, UT, WI)
- Significant recent uptick in concrete overlay use (since mid-1990s)
  - Proven performance
  - Versatility
  - Cost effectiveness
  - Improved guidance

Virginia Has Experience!

- 1920s: Virginia's 1st PCC OL on existing PCC
- 1930s thru 1980s: Some unbonded PCC OLs (primarily airports)
- 1990: Bonded PCC OL (US-13 in Northampton County)
- 1995: Bonded PCC OL (I-295 near Richmond)
- 1995: Bonded PCC OL (I-85 near Petersburg)
- 1999: UTW on Rt. 29N (S. of Charlottesville)
- 2008: Unbonded PCC OL on HMA, Newport News (two projects)

Service Life Expectations

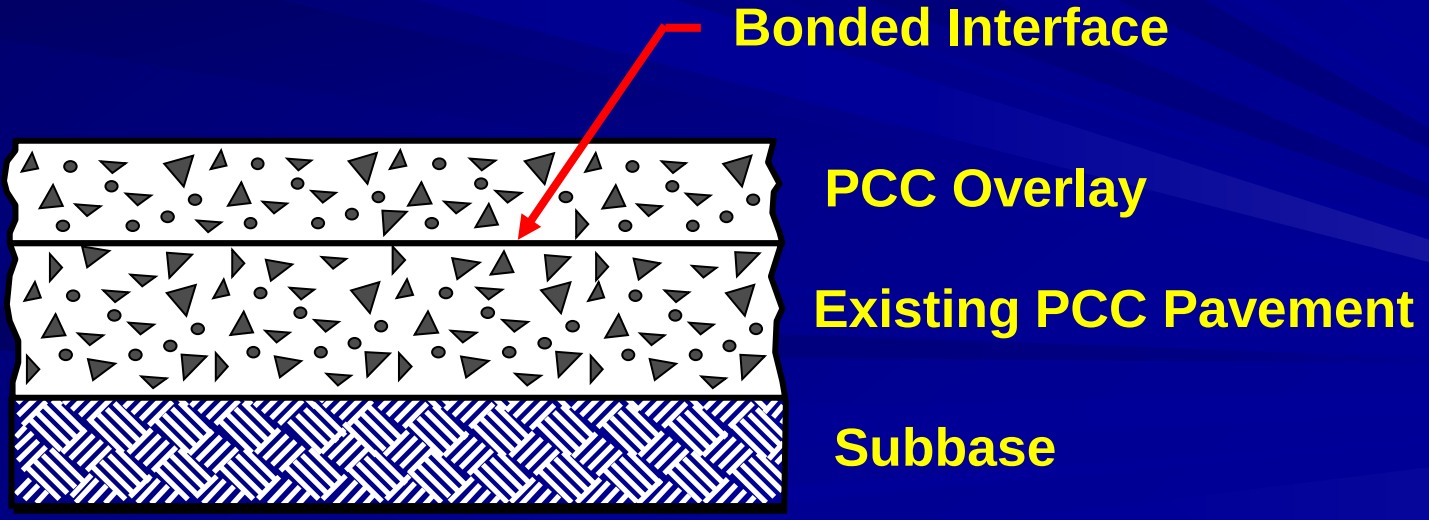
- Concrete overlay thicknesses of 4-6 inches:
  - 15+ years
- Concrete overlay thicknesses > 6 inches
  - 20 to 40+ years
- But depends on a number of factors:
  - Structural design
  - Existing pavement condition
  - Current and future traffic levels
  - Materials
  - Construction

What's Being Built on Route 58?

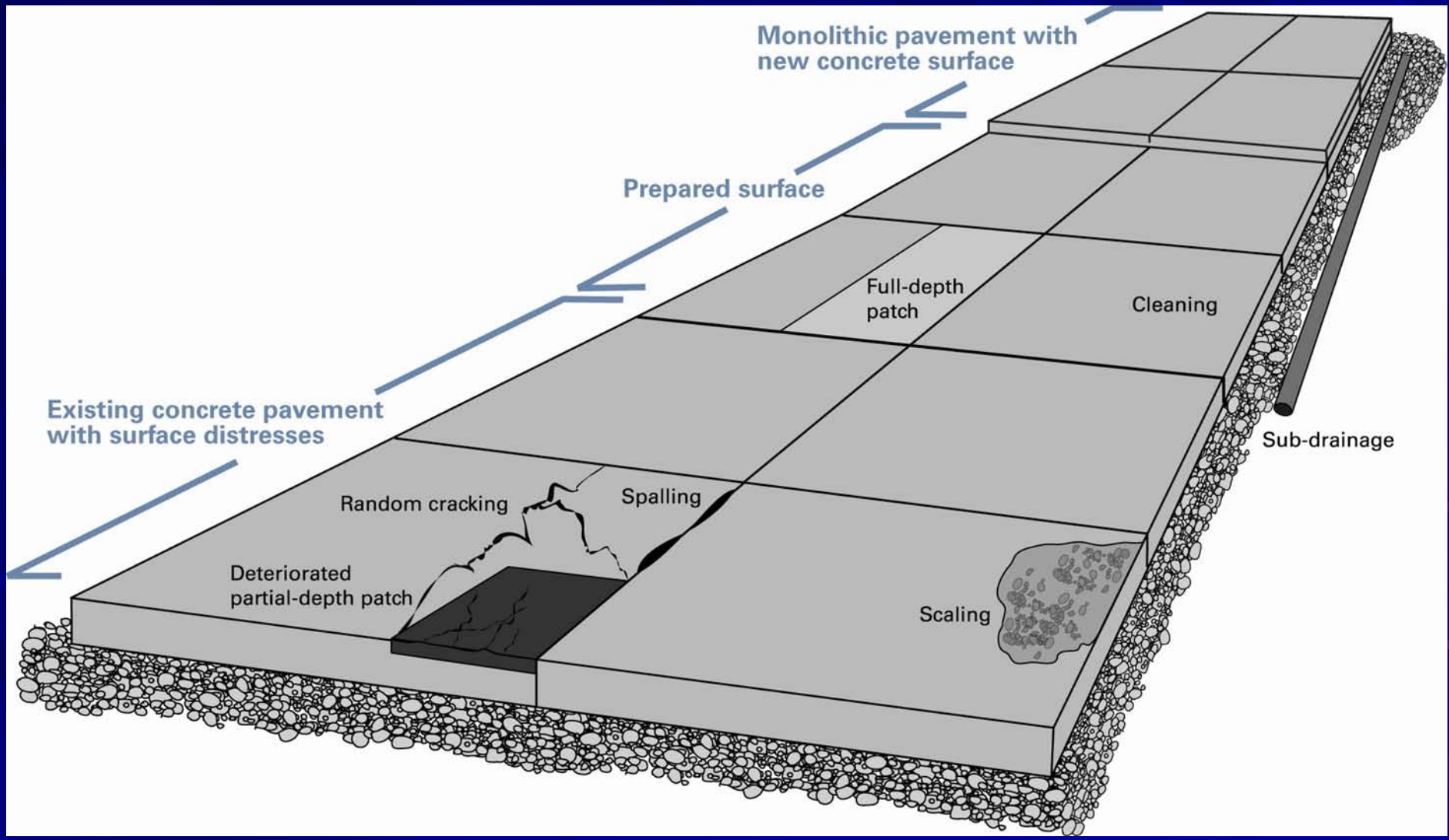
- Two Designs:
  - 4 inch bonded PCC on PCC
  - 7 inch unbonded PCC on PCC
- Existing PCC is a continuously reinforced concrete pavement (CRCP)

Bonded PCC/PCC Overlays

- 3 to 5 in PCC
- Bonded to existing PCC (monolithic behavior)
- Pavements in relatively good condition
- Increases structural capacity and rideability

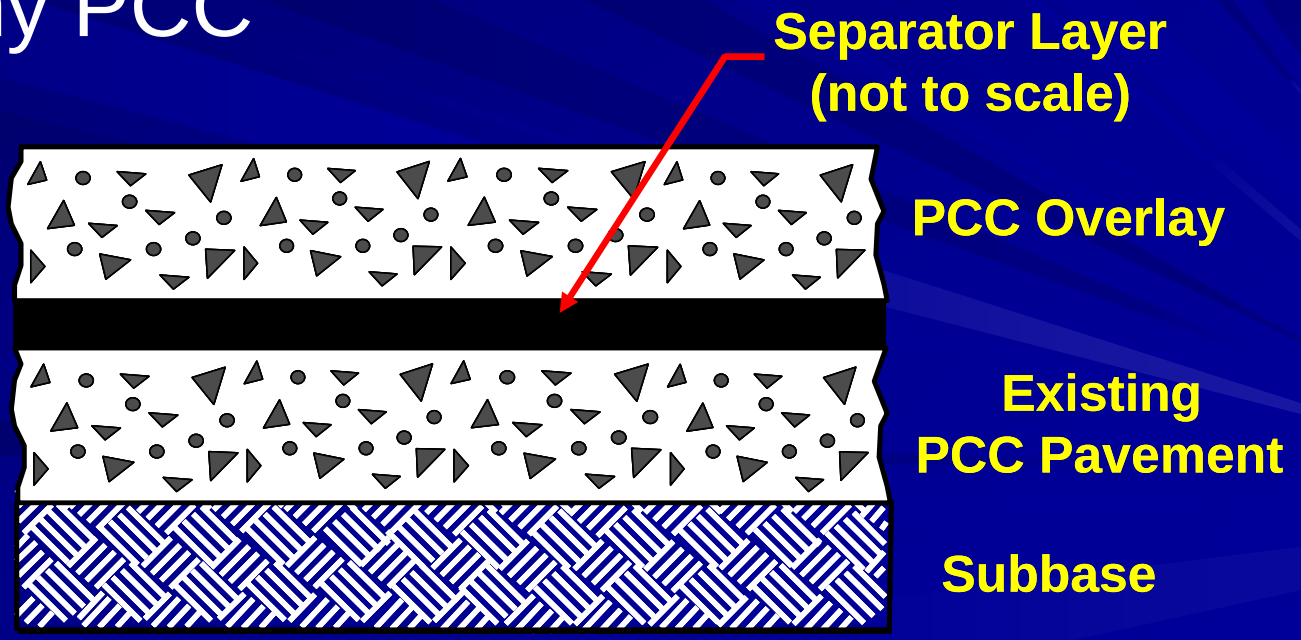


Bonded PCC/PCC

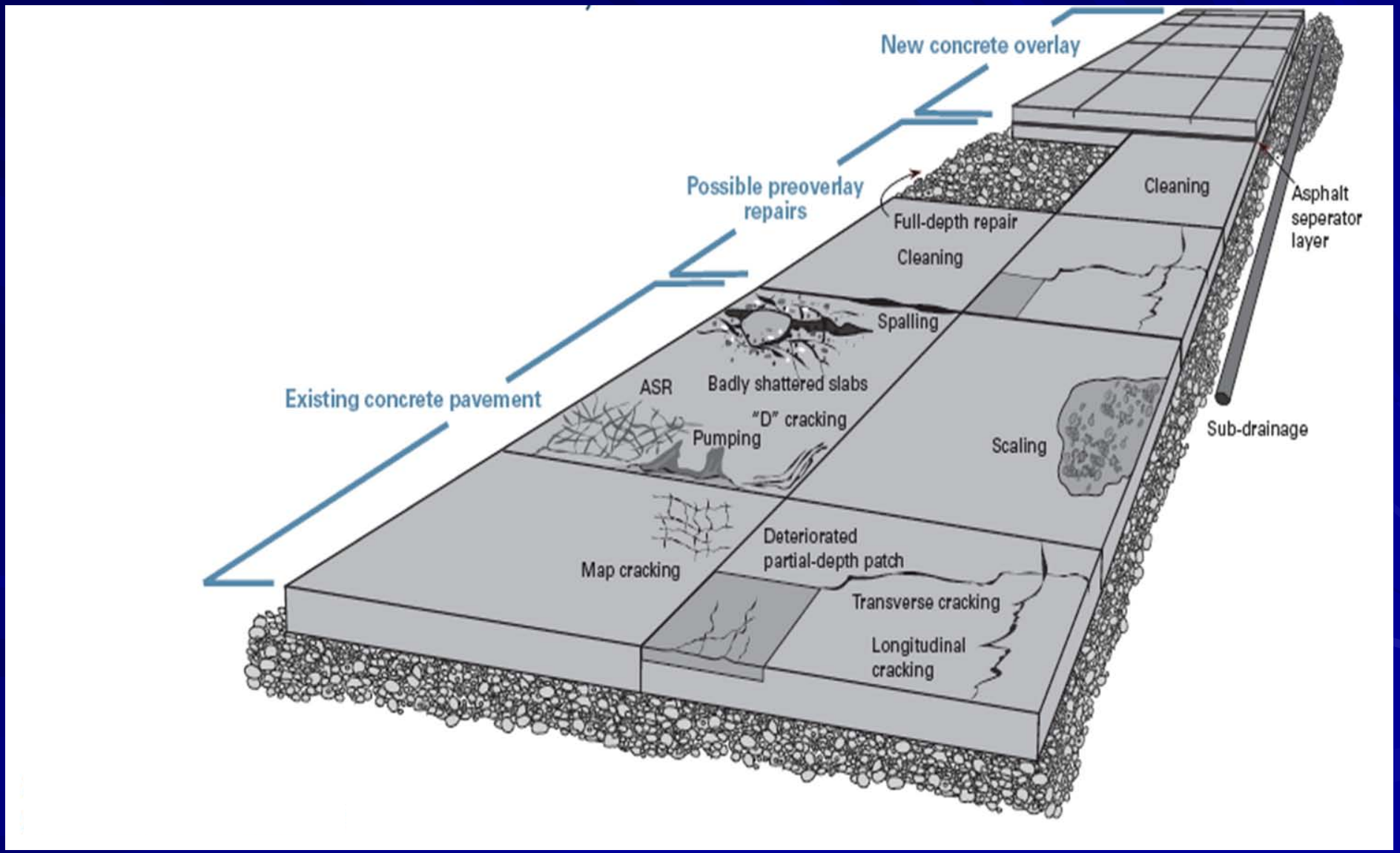


Unbonded PCC/PCC Overlays

- 7 to 12 in PCC
- Separated from underlying PCC
- Minimal surface preparation
- Virtually any PCC pavement type and condition



Unbonded PCC/PCC



Concrete Overlay Technology Transfer

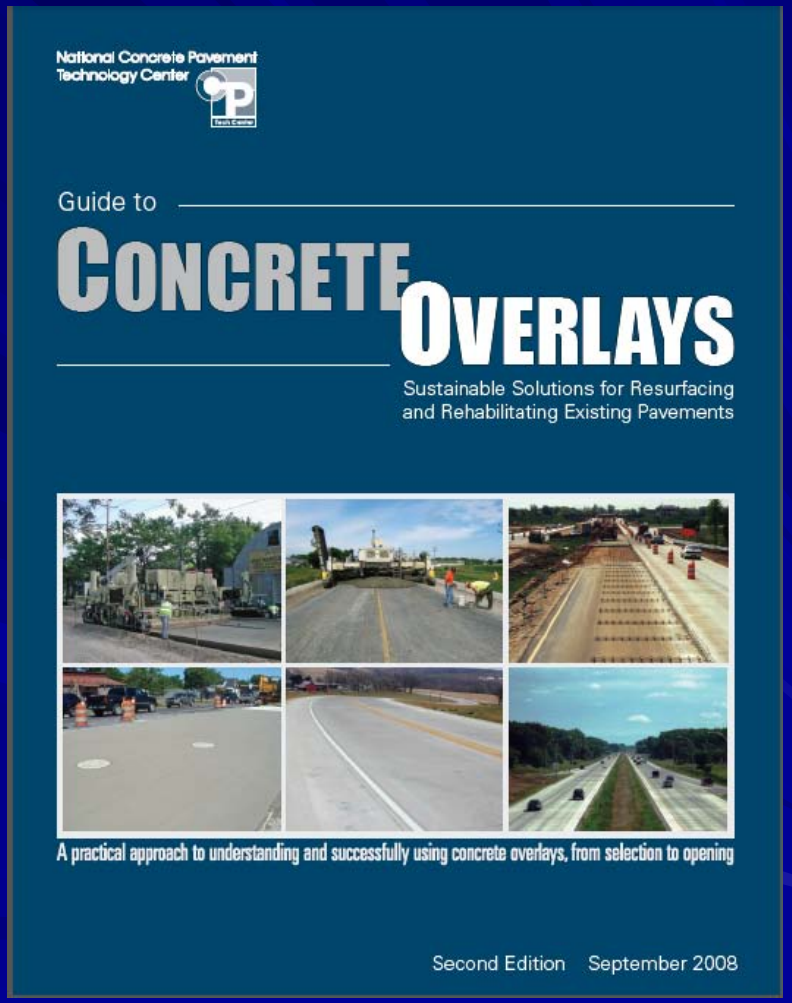
- Support the effective use of concrete overlays by highway agencies through:
  - Technical information
  - Guide documents
  - Workshops
  - Field visits
  - Demonstrations

FHWA Concrete Overlays Program

- Joint effort with CPTech Center (Ames, IA)
- Goal: Advance concrete overlay technology
- Available Documentation:
  - Guide to Concrete Overlays
  - Design of Concrete Overlays (Tech Summary)
- Outreach Activities
  - Field applications program
  - Workshops (also through FHWA ACPT)

Guide to Concrete Overlays

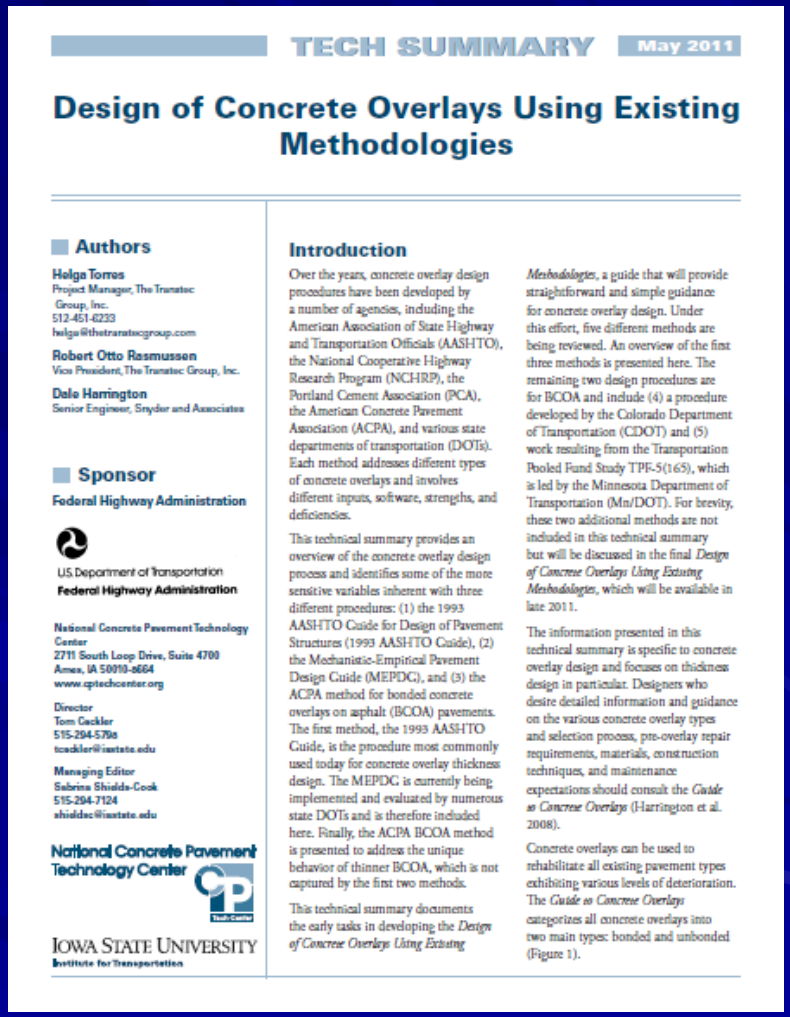
- September 2008
- Topics
  - Overlay Types
  - Project Evaluation
  - Overlay Design
  - Materials Selection
  - Work Zones
  - Overlay Construction
  - Specifications
  - Repairs



www.cptechcenter.org/publications/overlays/guide_concrete_overlays_2nd_ed.pdf

Design of Concrete Overlays (Technical Summary)

- July 2011
- Topics
  - Overlay Types
  - Background of Design Methods
  - Bonded Design Approaches
  - Unbonded Design Approaches
- Complete report expected late 2012



TECH SUMMARY May 2011

Design of Concrete Overlays Using Existing Methodologies

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Introduction

Over the years, concrete overlay design procedures have been developed by a number of agencies, including the American Association of State Highway and Transportation Officials (AASHTO), the National Cooperative Highway Research Program (NCHRP), the Portland Cement Association (PCA), the American Concrete Pavement Association (ACPA), and various state departments of transportation (DOTs). Each method addresses different types of concrete overlays and involves different inputs, software, strengths, and deficiencies.

This technical summary provides an overview of the concrete overlay design process and identifies some of the more sensitive variables inherent with three different procedures: (1) the 1993 AASHTO Guide for Design of Pavement Structures (1993 AASHTO Guide), (2) the Mechanistic-Empirical Pavement Design Guide (MEPDG), and (3) the ACPA method for bonded concrete overlays on asphalt (BCOA) pavements. The first method, the 1993 AASHTO Guide, is the procedure most commonly used today for concrete overlay thickness design. The MEPDG is currently being implemented and evaluated by numerous state DOTs and is therefore included here. Finally, the ACPA BCOA method is presented to address the unique behavior of thinner BCOA, which is not captured by the first two methods.

This technical summary documents the early tasks in developing the *Design of Concrete Overlays Using Existing Methodologies*, a guide that will provide straightforward and simple guidance for concrete overlay design. Under this effort, five different methods are being reviewed. An overview of the first three methods is presented here. The remaining two design procedures are for BCOA and include (4) a procedure developed by the Colorado Department of Transportation (CDOT) and (5) work resulting from the Transportation Pooled Fund Study TPF-5(165), which is led by the Minnesota Department of Transportation (Mn/DOT). For brevity, these two additional methods are not included in this technical summary but will be discussed in the final *Design of Concrete Overlays Using Existing Methodologies*, which will be available in late 2011.

The information presented in this technical summary is specific to concrete overlay design and focuses on thickness design in particular. Designers who desire detailed information and guidance on the various concrete overlay types and selection process, pre-overlay repair requirements, materials, construction techniques, and maintenance expectations should consult the *Guide to Concrete Overlays* (Harrington et al. 2008).

Concrete overlays can be used to rehabilitate all existing pavement types exhibiting various levels of deterioration. The *Guide to Concrete Overlays* categorizes all concrete overlays into two main types: bonded and unbonded (Figure 1).

www.cptechcenter.org/publications/overlay_design_TS_Jul2011.pdf

Field Applications Program

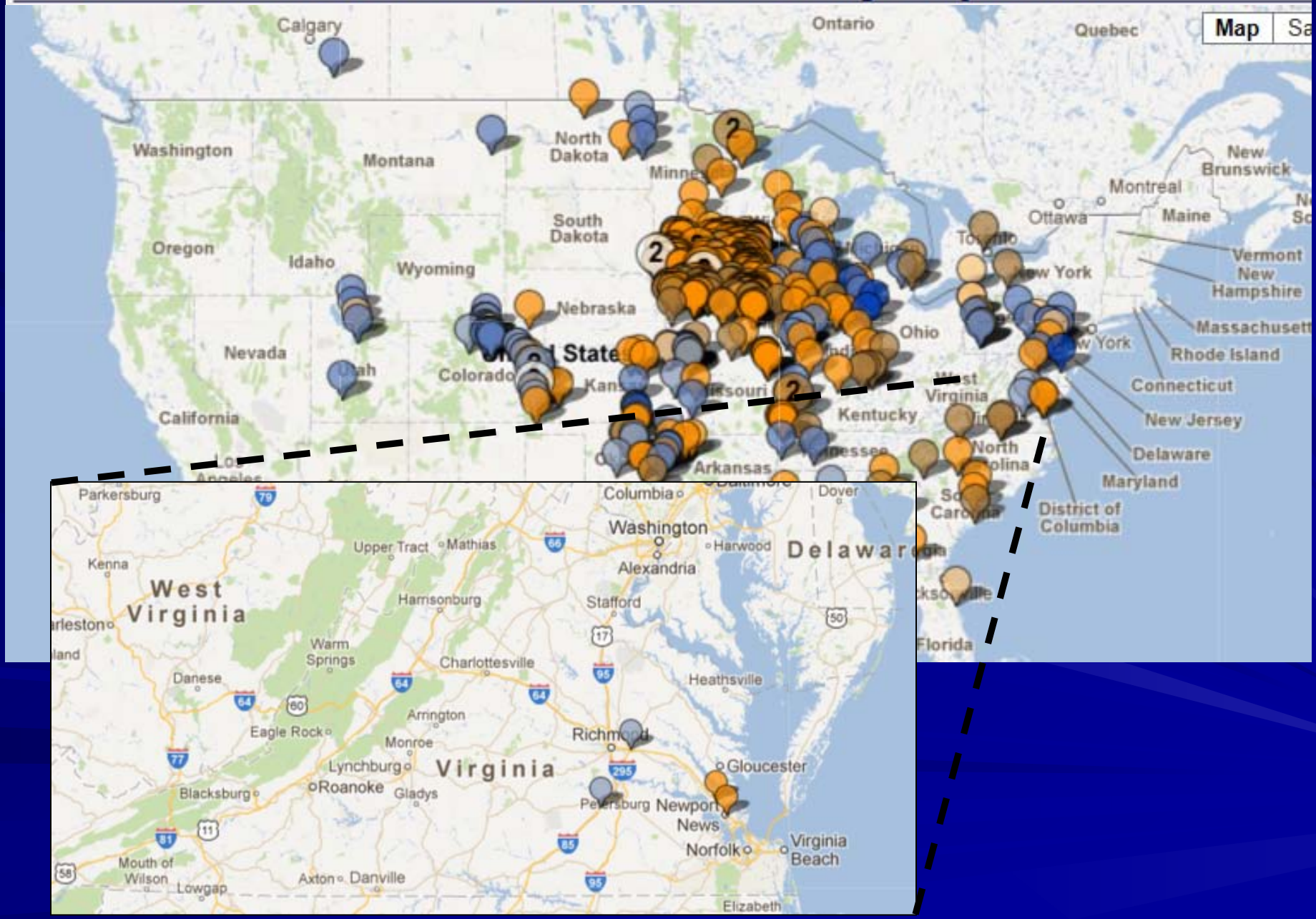
- Assistance to highway agencies in concrete overlay process
  - Initial site review and selection
  - Pavement evaluation
  - Design review
  - Specification review
  - Construction support
- FHWA mobile lab
- Funding for demonstration projects
- Construction assistance to over 8 SHAs, with technical outreach to 10+

American Concrete Pavement Association

- Technical publications on
  - Bonded Concrete Overlays (PCC/PCC)
  - Unbonded Concrete Overlays (PCC/PCC)
  - Whitetopping Overlays (PCC/HMA)
  - Thickness Design for UTW (PCC/HMA)
- National Concrete Pavement Explorer
  - Concrete overlay projects nationwide
  - Overlay type and some construction & performance data

www.acpa.org/webapps/overlayexplorer/index.html

The National Concrete Overlay Explorer



Turn Lane Project Newport News (2008)

The National Concrete Overlay Explorer

Turn Lane Whitetopping -- J. Clyde Morris Blvd @ Thimble Shoals
Type of Overlay: Unbonded on Asphalt
Application: Street/Road
Constructed in 2008 in Newport News, VA
Contractor: Denton Concrete Services
Engineer: Bob Long
Owner: City of Newport News

New Construction Details
Thickness: 6 in.
Project Size: 560 square yards
Joint Spacing: 6 ft
Doweled Joints: No
Joints Sealed: No
Interlayer Matieral: None
Integral Widening Constructed with Overlay: NA
Opening Strength: 2000 psi
Opening Time: 24 NA
Reinforcing: NA
Existing Pavement Type: Asphalt

Current Conditions
Still in Service: Yes
Current Condition: Excellent condition -- no repairs.
Last Condition Rating: N/A

Some Recent Innovations

- Mich DOT: Thin, unbonded PCC OL of composite pavements
- IL DOT: Use of structural fibers in thin PCC OL
- Mo DOT (& others): Fabric interlayers
- IA DOT: Stringless PCC OL paving
- Mn/Road: Pervious PCC OL

Summary

- PCC overlays offer a long-lasting, low maintenance *sustainable* rehabilitation solution
  - Bonded Solutions
  - Unbonded Solutions
- Each a unique structure with specific applications and design/construction considerations
- A number of resources available
- New innovations being evaluated

THANK YOU!

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