What If?

• New or improved sustainable technologies could solve some of these challenges
• Country’s 1.3 million miles of deteriorated pavements rehabilitated quickly and sustainably at a fraction of the cost of reconstruction
• Agencies could extend the return on their original investment by taking advantage of the equity remaining in deteriorated pavements
• Pavement structural capacity could be enhanced to meet the demands of the ever increasing traffic volumes (240% increase 1965 to 2005)
• Get in, get out, and stay out – construction is a major source of traffic delays
We Know There Are Solutions using Concrete Overlays

- Concrete overlays reuses the existing pavement
- As long as existing pavement remains stable and uniform a concrete overlay can be placed, re-placed or recycled as needed
- Thicker unbonded overlay
  - a new pavement
  - old pavement as a base
- Life cycle costs are some of the best
National Concrete Pavement Technology Center Board

Overlay Guide (what do we know!)

Concrete Overlay Application Program

Field Research (What we don’t know & how to solve a problem)

Field Application Program (We can build it!)

Simpler Design Explanation of Current Programs
Concrete Overlay Guide second edition

Contents

1. Overview of Overlay Families
2. Overlay types and uses
3. Evaluations & Selections
4. Six Overlay Summaries (11”x17 “sheets)
5. Design Section
6. Miscellaneous Design Details
7. Overlay Materials Section
8. Work Zones under Traffic
9. Key Points for Overlay Construction
10. Accelerated Construction
11. Specification Considerations
12. Repairs of Overlays
Family of Concrete Overlays

Thinner

Concrete Overlays

Thicker

Bonded Overlay Family

- Bonded Concrete Overlay of Concrete Pavements
- Bonded Concrete Overlay of Asphalt Pavements
- Bonded Concrete Overlay of Composite Pavements

Unbonded Overlay Family

- Unbonded Concrete Overlay of Concrete Pavements
- Unbonded Concrete Overlay of Asphalt Pavements
- Unbonded Concrete Overlay of Composite Pavements

Bond is integral to design
Old pavement is base
Maintenance & Rehabilitation Curve

The real challenge is identifying the right treatment at the right time

- Excellent
- Good
- Fair
- Poor
- Deteriorated
- Failed

Preventive maintenance
Minor rehabilitation
Major rehabilitation
Reconstruction

Existing pavement condition

Time
Concrete Overlay Field Application Program

The purpose of the program is to increase the awareness, knowledge and strengthen confidence in concrete overlay applications among state DOTs, cities, counties, contractors, and engineering consultants.
Concrete Overlay
Field Application States

Joined the Program
1. Delaware
2. Georgia
3. Louisiana
4. Maryland
5. Nevada
6. New Mexico
7. North Dakota
8. Pennsylvania
9. South Dakota
10. Washington
11. West Virginia

Interested States
1. Arkansas
2. California
3. Indiana
4. Kentucky
5. Maine
6. Minnesota
7. Nebraska
8. North Carolina
9. Texas
10. Virginia

5 States – 6” Bonded Overlays over HMA (6’x6’ joints)
3 States – 6” Unbonded Overlays over Concrete (6’x6’ joints)
1 State – 7” Bonded CRCP over Plain Jointed Concrete

Iowa – 2009-2010 Field Application Research Projects
Concrete Overlay Field Application Program

• 4 National teams of three experts on concrete overlays will provide assistance to each participating state

• Conduct initial field site review

• Walk through the evaluation process

• Walk through the design phase

• Attend pre-pour, pre-bid or pre-construction conference

• Attend during construction & may use mobile lab
Concrete material and Pavement Testing Mobile Laboratory

• With the concurrence of each State DOT, the CP Tech Center’s Mobile Concrete Lab will be on-site during construction of the overlay demonstration projects.

• Will perform comprehensive concrete testing (for each type of overlay) as well as offer technical support to the State DOT.
Project Reports

• For each state a project report will be developed that includes the mobile lab report
  - Site selection
  - Overlay type and design
  - Construction issues
  - Benefits and drawbacks
  - Recommendations
  - Lessons learned

• All State reports will be completed and also compiled into one report
Technical Working Group (TWG) Meetings

• Exchange of lessons learned between participating State DOT’s

• Held first TWG conference call May 18, 2009 with nine states participating
  ▪ Review uses & benefits
  ▪ States share evaluation criteria and overlay selection process
  ▪ States share their issues, solutions and lessons learned
  ▪ Suggestions on update of Overlay Guide
  ▪ Overall information sharing among states
CP Tech Center / FHWA Guide for Existing Concrete Overlay Design Methodology

- Design programs are not always user friendly
- Programs take a significant amount of input
- What is needed is straightforward and simple guidance for concrete overlay design
- CP Tech Center / FHWA are developing Overlay Design Guide (2010) that summarizes selected design computer programs with examples
- With guidance, DOT’s can rest assured that their concrete overlay designs are based on sound engineering fundamentals, and validated by field performance
There is a need to improve upon the construction techniques for the construction overlays to meet the public needs for mobility and access.

Tested ways of project development, site preparation, construction methods and traffic control work well for thick overlays and closed road construction.

New methods are needed in each area to meet the needs of the public we serve.
CP Tech Center/FHWA on Overlay Research

The research elements for four research projects (2009):

• Establish profile grades & machine control before or immediately after letting

• Determine ways to guide longitudinal joint forming operation to match the underlying joint alignment

• Determine the appropriate opening strength for depths of concrete of 6 inches or less

• Determine ways of handling traffic control for construction of single lane overlays as part of a two lane or multilane overlay

• Determine the best way to establish the level of need and timing of milling for existing asphalt surface preparation

• Minimizing pavement train width

• Use of innovative materials, such as geotextile layers, for use as bond separator layers
Global positioning system (GPS) controls will likely be able to eliminate the need for a string line in the future.
Total Stations Control

Robotic Total Stations and Prisms

Leica Machine Control Command Center
GPS Saws for Bonded Concrete Overlays

Matching Centerline Joints by Satellite
Stingless Paving

Ease of Construction in Tight Work Areas
Minimum Clearance Paver
Moveable String Line
Existing Paver Adjusted for Zero Clearance

- Notice edge of paver riding next to curb
Lessons Learned
Bonded on Concrete
Keys to Success

• Bond is important for good performance as a monolithic pavement.
• Concrete aggregate used should have thermal properties similar to that of existing pavement to minimize shear stress in bond.
• Matching joints with underlying pavement allows structure to move monolithically.
• Existing joints must be in fair condition or be repaired
• Timing of joint sawing is important.
• Cut transverse joints full depth +1/2” and longitudinal joints at T/2.
• Curing should be timely and adequate, especially near the edge, due to the surface-to-volume ratio and the risk of early-age cracks.
• Width of transverse joint of overlay to be equal to or greater than underlying crack width of the existing pavement.
Surface Preparation for Bonded Overlay
Bonding is Critical

- Shotblasting
- Milling
Bonded Overlay of Concrete - Full Depth Cut

- Overlay joint
- New overlay transverse joint
- Concrete overlay
- Sawcut in existing slab
- Crack in existing slab
Pre-overlay repairs
Poor Spot Patch for Bonded Overlay over Concrete
Maintaining Bond

Replaced Asphalt Patch will Concrete Patch
Coefficient of Thermal Expansion (CTE)

- Overlay CTE should be similar to underlining pavement.
- If not near the same at least overlay CTE should be lower than existing pavement.

Shear | Tensile stress | Overlay | Shear

Existing Pavement
Poor Bonding: Delamination of Concrete Overlay over Concrete
Bonded over Asphalt/Composite
Keys to Success

- Bonding is critical
- Small square panels reduce curling, warping, & shear stresses in bond (1.5 times thickness).
- Mill if necessary to correct crown, remove surface distresses, improve bonding. Be sure to leave 3” of HMA after milling.
- HMA surface temperature below 120 F before paving.
- Transverse joints must be sawed T/3
- Joints in the overlay should not be placed in wheel paths, if possible
- Application of curing compound or curing methods must be timely and thorough
Mark Concrete Patches on Asphalt Pavements to Saw Cut Bonded Overlay
Surface Preparation

- Milling AC surface
  - Remove rutting
  - Restore profile
  - Enhance bond

- Minimum AC thickness remaining after milling: 3 to 5 in

- Surface cleaning
Purpose of Milling of Asphalt for Bonded Overlay over Asphalt

- Remove significant Surface distortions
- Reduce high spots to insure minimum overlay depth
- Match adjacent lanes
- Help insure good bond

Excessive milling of existing asphalt beyond asphalt lifts (tack line)
Result Can be Structural Failure of Concrete Bonded Overlay over HMA
Widened Pavements

Tiebars stapled to asphalt if overlay is < 5 in. (12.7 cm). If ≥ 6 in. (15.2 cm), then place tiebar in the center of the overlay.

Keep joint out of wheel line where possible.

Sawcut joint only if joint is in the wheel path.

Extend tiebar only if wheel loads are to be on concrete widening.

Existing asphalt (≥ 3 in. (8 cm) if bonded; ≥ 1 in. (2.5 cm) if unbonded)

Existing concrete

3–6 ft (0.9–1.8 m) concrete widening unit

Previous widen with asphalt or concrete

Bonded or Unbonded Overlay of Asphalt or Composite. (Previously widen with asphalt or concrete. To be widen with new overlay)
Iowa 175 Longitudinal Crack
Jointing

• Maximum spacing of 3’ to 8’
  - Limit 1.0 to 1.5 times thickness in feet.
  - Some agencies include tie bars at longitudinal joints >4”
  - No dowels (aggregate interlock relied upon)
Longitudinal Joint Layout

- 2 ft x 2 ft
- 3 ft x 3 ft
- 4 ft x 4 ft
- 6 ft x 6 ft

Outer Shoulder

Traffic

12 ft
Unbonded Overlay of Concrete Pavements
Keys to Success

• Full-depth repairs are required only where structural integrity is lost at isolated spots.

• Separator layer (normally 1” asphalt) is important to isolate unbonded overlay from underlying pavement and minimize reflective cracking.

• With heavy truck traffic, adequate drainage design may be important to reduce pore pressure in asphalt separation layer.

• Some states are experimenting with geotextile materials for separation layer.

• Faulting of 3/8 in. or less in the existing concrete pavement is not a concern when asphalt separation layer is 1 in. or more.

• Shorter joint spacing helps minimize curling and warping stresses. Transverse joints at 1.5 times thickness for <5” and 2 times thickness 5” or greater up to 15’.

• No need to match joints with those of the underlying concrete pavement.
Unbounded Overlays Can be Placed over Poor Concrete Pavements
Separator Layer

• Required for good performance
  – Isolate overlay from existing pavement
    ➢ Prevent reflection cracking
    ➢ Prevent bonding/mechanical interlocking
  – Provide level surface for overlay construction

• Recommended interlayer material:
  – 1-2 inch dense-graded HMA- $3+ per sq.yd
  – GEOTEXTILE - $1.2+ per sq.yd
Geotextile Separation Layer (Interlayer)

No turn

No wrinkles
Asphalt Separation Layer
Need for Adequate Interlayer

OVERLAY

"KEY"

OLD PAVEMENT

THICKER INTERLAYER (1"

SMOOTHER SLIP PLANE
Unbonded Over Asphalt/Composite
Keys to Success

- Milling may be required to eliminate surface distortions of 2 in. (5.1 cm) or more
- Complete repairs at isolated spots where structural integrity needs restoring
- Concrete patches in the existing pavement should be separated from the overlay
  - with a thin layer of fabric or other bond breaker;
  - or joints should be sawed in the overlay around the concrete patch perimeter
- Surface temperature of existing asphalt pavement should be maintained below 120°F (48.9°C) when placing overlay
- Partial bonding between the overlay and the existing asphalt pavement is acceptable and may even improve load-carrying capacity
Overlay on Poor to Deteriorated Asphalt Pavement
• Tented panels with significant movement can be repaired to relieve the pressure and provide uniform support before construction of an overlay.

• Faulted panels that do not exhibit continuing movement have proven to provide adequate support for concrete overlays.

• Edge drains have also been successfully used to reduce the progression of faulting.
Over Milling Existing HMA

Removed 6 in of existing 9-in HMA Pavement

Remaining HMA severely damaged from trucks hauling away millings
Tie Baskets to Pavement
$y = 0.3599x^2 - 2.0216x + 16.807$

$R^2 = 0.7705$
THANK YOU!

Dale S. Harrington
Representing the National Concrete Pavement Technology Center
dharrington@snyder-associates.com
515-964-2020