OVERVIEW OF CONCRETE OVERLAYS

IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

Who is supporting this webinar?

PCA Since 1916 America's Cement Manufacturers™

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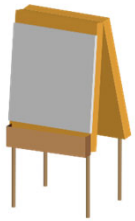
2

Introductions

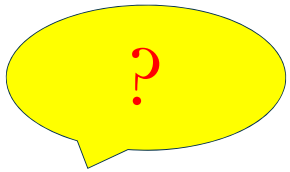
- Dr. Peter Taylor, ptaylor@iastate.edu
- Gordon Smith, glsmith@iastate.edu
- Greg Dean, gdean@pavementse.com

- **Questions are encouraged since we are practicing physical distancing!**



Questions from last week

- How much traffic can an overlay carry?
- What about widened lanes?
- Where can I get more information on…?
- How do I choose what system to use?



Learning Objectives

- Describe how bonded and unbonded overlays perform under load
- Discuss how to select which system to use in a given situation
- List the actions required to evaluate the existing pavement

The Concrete Overlay Webinar Series

I. Introduction to Concrete Overlays
II. Overview of Concrete Overlays / Existing Pavement Evaluation and Overlay Selection
III. Concrete Overlay Design
IV. Plans, Maintenance of Traffic and Construction
V. Maintenance of Concrete Overlays and Resources Available to you.

And throughout - examples of how concrete overlays are performing around the country

OVERVIEW OF CONCRETE OVERLAYS

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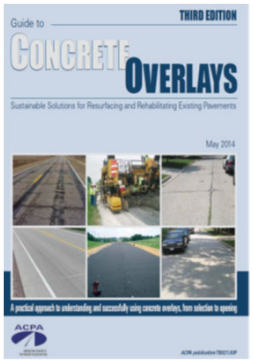
Tech Center

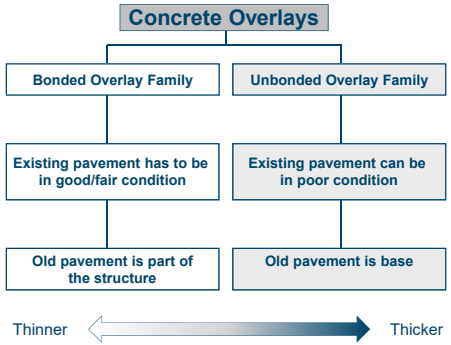
The Guide to Concrete Overlays

- 1st Edition – 2007
- 2nd Edition – 2008
  - Added Managing Concrete Work Zones Under Traffic
- 3rd Edition – May 2014
  - Added Synthetic Fibers
  - Evaluation Flow Chart
  - Geotextile Interlayer
  - 3 D Survey
  - Stringless Paving
  - Plate Dowels

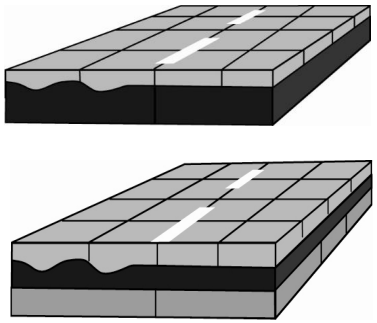


CP Tech Technical Guides on Overlays

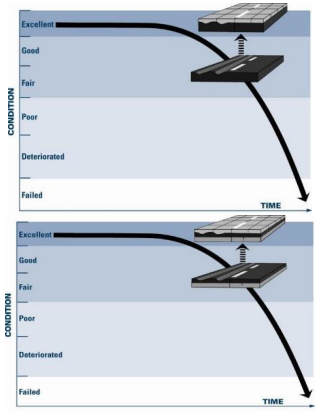
System of Concrete Overlays on Asphalt or Concrete



Bonded Concrete Overlay of Asphalt or Composite Pavement



Bonded Concrete Overlay of Asphalt or Composite Pavement

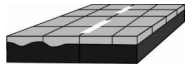


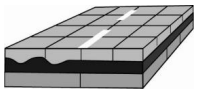
3"–6" thickness

Existing pavement condition
Fair or better structural condition with surface distress

Applications
- To eliminate surface defects such as rutting and shoving
- Improve surface characteristics like friction, noise, and rideability
- To increase structural capacity where traffic loads have increased or will increase

Bonded Over Asphalt/Composite Keys to Success

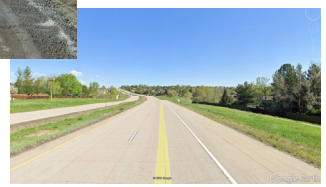




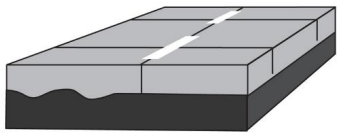
- Bonding is critical
- Small square panels reduce curling, warping, & shear stresses in bond (1.5 times thickness).
- Mill to remove surface distresses or improve bonding.
- Recommendation to leave 3” of HMA after milling.
- HMA surface temperature below 120° F before paving.
- Joints in the overlay should not be placed in wheel paths, if possible
- Application of curing compound is critical

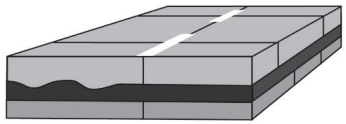
Wadsworth Blvd Near C-470 on the SW Side of Metro Denver

- Constructed in 2001
- 6x6x6
- Bonded Design
- Condition in 2019



Unbonded Concrete Overlay of Asphalt or Composite Pavement





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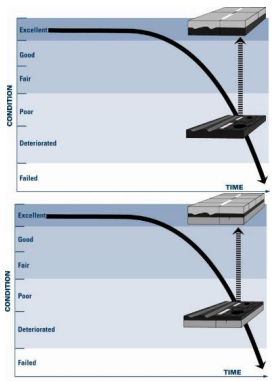


4” - 11” thickness

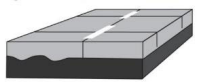
Existing pavement condition

Deteriorated (severe rutting, potholes, alligator cracking, shoving, and pumping) but stable and uniform

Applications

- To restore or enhance pavement’s structural capacity
- To increase pavement life equivalent to full-depth pavement
- To eliminate deterioration problems
- To reduce urban heat island effect by increasing pavement surface albedo

Unbonded Over Asphalt/Composite Keys to Success



- Milling to eliminate surface distortions of 2 in. or more
- Complete repairs at isolated spots where structural integrity needs restoring
- Concrete patches of the existing pavement should be separated from the overlay
- Surface temperature of existing asphalt pavement should be maintained below 120ºF (48.9ºC) when placing overlay
- Partial bonding between the overlay and the existing asphalt pavement is acceptable and may even improve load-carrying capacity

Condition of Existing Pavement

Can be in poor condition

Unbonded Overlay

Runway 12-30 at Renner Field in Goodland,KS

- Constructed in 1974
- 8” thick
- Unbonded on asphalt
- Condition in 2014

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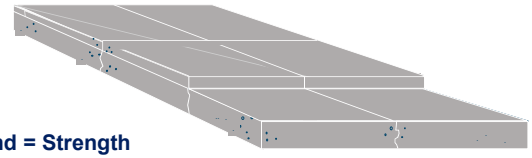
Bonded Concrete Overlay of Concrete Pavement

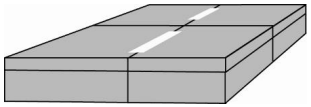
- Consists of a thin concrete layer on top of an existing concrete surface.
- Specific steps are taken to bond the new concrete overlay to the existing concrete.

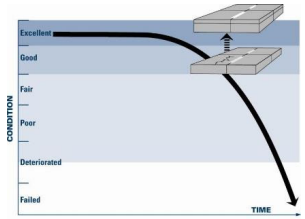


Bond = Strength

Bonded Concrete Overlay of Concrete Pavement

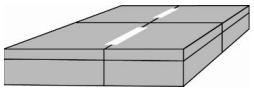
2” – 5” Thick



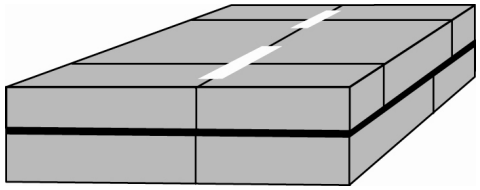


Bonded Overlay on Concrete Keys to Success

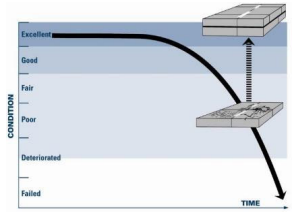
- Bond is essential
- Concrete aggregate used in the overlay should have thermal properties similar to that of existing pavement (CTE)
- Matching joints with underlying pavement allows structure to move monolithically.
- Existing joints must be in fair condition or be repaired
- Timing of joint sawing is important
- Cut transverse joints full depth +1/2” and longitudinal joints at T/2.
- Width of transverse joint of the overlay should be equal to or greater than underlying crack width of the existing pavement.
- Curing should be timely and adequate



Unbonded Concrete Overlay of Concrete Pavement



Unbonded Overlay of Concrete Pavement

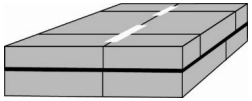


4” - 11” thickness

- Use when existing pavement is in poor condition, including material-related distress such as D-cracking.
- Pavement and subbase should be stable and uniform except for isolated areas that can be repaired.

- Use to restore structural capacity of the existing pavement and increase pavement life equivalent to full-depth pavement.

Unbonded Overlay on Concrete Keys to Success



- Full-depth repairs – only where structural integrity is lost at isolated spots.
- Separator layer (normally 1" asphalt or geotextile fabric)

- Use to restore structural capacity of the existing pavement and increase pavement life equivalent to full-depth pavement.
- Faulting of 3/8 in. or less in the existing concrete pavement preferred
- Shorter joint spacing helps minimize curling and warping stresses.
- Not necessary or recommended to match joints with those of the underlying concrete pavement.

Options for a Separation Layer

- **Asphalt separation layer**
  - Serves as a good cushion for the overlay
  - Can help prevent keying of the overlay in faulted concrete pavements
  - Stripping of the asphalt binder can occur due to poor drainage of the interlayer and heavy truck traffic.
- **Nonwoven geotextile fabric**
  - Easy to place interlayer at less than half the cost of asphalt.
  - Improved drainage, but must have outlet
  - Faulting should be minimal to prevent keying of the overlay

Unbonded Overlays Can be Placed over Poor Concrete Pavements

Existing Pavement Preparation

- Remove loose material/debris
- Placement of cement base flowable fill in deteriorated areas

Interstate 86 near Olean, NY

- Constructed in 2004
- 9” thick
- Unbonded on Concrete
- HMA interlayer
- Condition in 2019

PROJECT EVALUATION AND SELECTION

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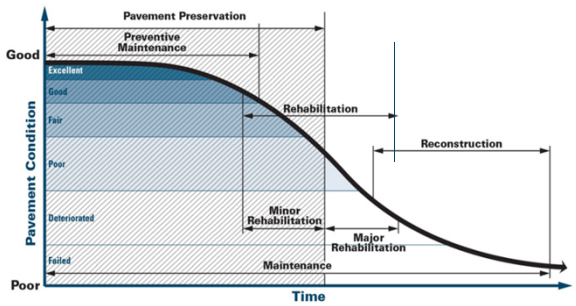
Selecting the right concrete overlay for the existing pavement condition

Asset Management Through Concrete Resurfacing



Preservation = Preventative Maintenance + Minor Rehabilitation

Selecting the Appropriate Concrete Overlay Solution

1. Design Objectives
   - Desired pavement life?
   - Desired level of service?
2. Condition of the Existing Pavement
3. Budget Objectives
4. What overlay will achieve these objectives?

Pavement Evaluation

- Concrete overlays require “relatively” uniform support conditions.
  - Unbonded overlays are less sensitive to uniformity, stiff support conditions lead to little or no slab deflections.
- Premature overlay failure can often be traced to “choosing the wrong project”.
- The evaluation of the existing pavement is paramount to determine if adequate support and movement control exists, or if it can be cost-effectively achieved.

Evaluation of Existing Pavement

- Will a bonded concrete overlay act as a monolithic unit with the underlying pavement?
- Or will an unbonded overlay be necessary to meet the same criteria but with the added burden of meeting critical elevation constraints?
- To have a successful overlay, the good and poor characteristics of the existing pavement must be understood.

Pavement Evaluation Objectives

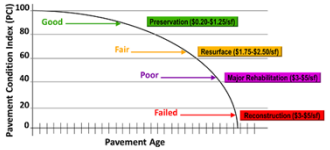
- Document existing pavement condition
- Obtain necessary design inputs
- Identify field constraints

Evaluation Steps

1. Pavement History (Records)
2. Field Review of Distresses
3. Coring of Pavement
4. Field Tests Where Necessary
5. Condition Assessment of the Pavement Profile

1. Pavement History

- Age of Different Thickness Layers
- Estimate Remaining Life
- Mixture materials,
- Design & construction date and method,
- Performance Grades of HMA lifts (records)
- Type and Amount of Traffic Now and in the Future
- Pavement Management Records
- Desired Design Life
- Elevations and Grade Restrictions



2. Field Review of Distress/Limitations

- Identify distress:
  - Type
  - Amount
  - Severity
- Evaluate uniformity of distress conditions
- Identify areas for further testing/evaluation
- Document repair quantities

Pavement Evaluation Data Elements

- Pavement condition
- Pavement Thickness
- Support Condition
- Materials and soil properties
- Traffic volumes and loadings
- Climatic conditions
- Drainage conditions

Other Project Factors

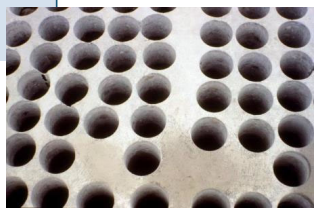
- Project geometry
- Vertical restrictions
  - Bridges
  - Curb/gutter
  - Cross streets
- Utilities/fixed structures
- Existing grades & cross slopes
- Shoulders/ditches
- Traffic control constraints

From the Distress Survey

- Does the pavement condition/distress lend itself to a PCC overlay solution?
- What pre-overlay repair (type and amount) may be required?
- Are there other project factors that should be considered?
- What additional field testing is required to help document pavement condition?

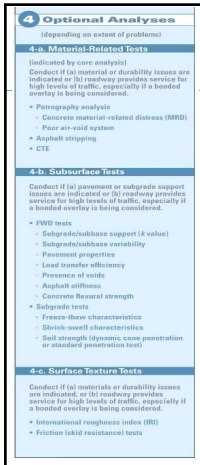
3 Core Analysis

- **Type of distress**
- **Depth of distress**
- **Verification of thickness for pavement base/subbase**



3. Coring

- Layer confirmation
- Layer thicknesses
  - Variability
  - Minimum requirements for thin overlays
- Subsurface conditions
  - Stripping
  - Delaminations
- Samples for laboratory testing
  - Material properties



Rare but sometimes necessary

- Distress (type, severity, amount) and level of roadway drives the need for and amount of field testing
- Bonded systems generally require more detailed and thorough field testing and evaluation than unbonded systems

Evaluations of Existing Pavements

- Evaluation is also used to determine:
  - Required repairs where needed
  - Develop thickness design inputs
  - When combined with an overlay can the existing pavement help carry anticipated traffic as:
    - an integrated part of the pavement (bonded)
    - or serve as a base or subbase (unbonded)

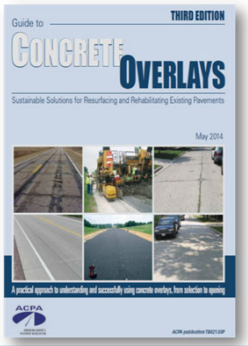
Initial Evaluation (step 5)

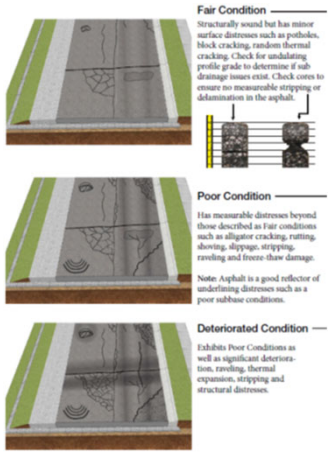
5 Condition Assessment Profile

Concrete	Asphalt / Composite
Surface Deficiencies	**Surface Deficiencies**
• Friction loss	• Bleeding/flushing
• Joint deterioration (low to medium)	• Block cracking
• Map cracking (non-ASR)	• Friction loss
• Popouts	• Noise
• Noise	• Corrugation
• Scaling	• Joint reflective cracking
• Roughness (not distress-related)	• Roughness (not distress-related)
• Plastic shrinkage cracks	• Rutting
• Thermal shrinkage cracks	• Weathering/raveling
• IRI	• Shoving
• Other	• Slippage
Structural Deficiencies	• IRI
• Corner breaks	• Other
• Joint deterioration (severe)	**Structural Deficiencies**
• Tented panels	• Fatigue (alligator) cracking
• Longitudinal cracking	• Depressions
• Pumping/faulting	• Heaves
• Punchout	• Longitudinal cracking
• MRD (medium to severe)	• Potholes
• Transverse cracking	• Transverse thermal cracking
• Subgrade/subbase condition	• Rutting/shoving
• Other	• Subgrade /subbase condition
	• Other

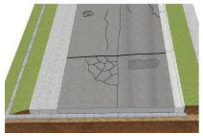
Pavement Evaluation Report and Pavement Condition Rankings

Concrete Overlay Selection for Existing Asphalt





Overlay Selection for Existing Asphalt or Composite Pavements in "Good" to "Fair" Condition



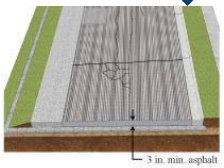
Pavement is structurally sound but has surface distresses such as potholes, block cracking, or random thermal cracking.

Pre-Overlay Question

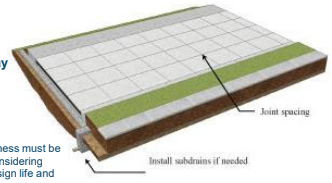
Can milling and minor spot repairs cost effectively solve deficiencies, bring the pavement to "Good Condition" and meet other constraints (i.e., vertical clearance, shoulders, safety rails, foreslopes, etc.) to allow for bonded overlay?

NO

Yes



Bonded Concrete Overlay



Note: Concrete overlay thickness must be appropriately designed considering estimated traffic, desired design life and budget.

Overlay Selection for Existing Asphalt or Composite Pavements in Poor to Deteriorated Condition

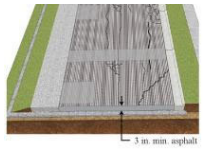
Pavement has measurable distresses such as alligator cracking, rutting, delamination, shoving, slippage, stripping, raveling thermal expansion, cracking and structural distresses.

Stripping /Delamination

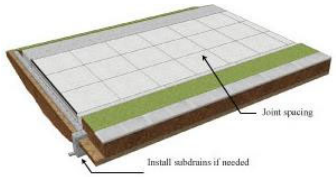
Yes

Pre-Overlay Question
Can milling and/or structural repairs cost effectively solve deficiencies, bring the existing pavement to a condition that will provide uniform support as a subbase, meet other constraints (i.e., vertical clearance, shoulders, safety rails, foreslopes, etc.), that allow for an unbonded overlay?

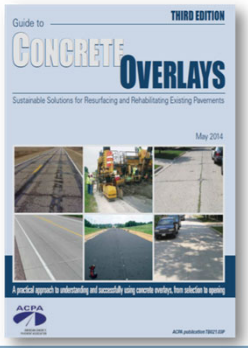
NO

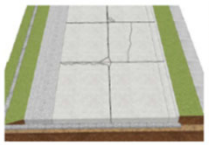


Unbonded Concrete Overlay

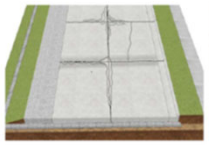


Concrete Overlay Selection for Existing Concrete

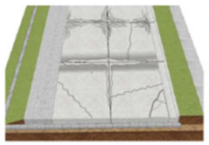




Fair Condition
Structurally sound but has minor surface distresses such as random cracking, periodic partial-depth joint spalling and shadowing. Check for undulating profile grade to determine if sub drainage issues exist or other foundation issues such as secondary consolidation of an open graded base exists.

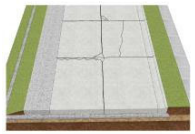


Poor Condition
Has measurable surface distresses beyond those described as fair condition. These include: full-depth joint deterioration, working cracks, spot structural failures, faulting and/or material related distresses (MRD).



Deteriorated Condition
Exhibits Poor Conditions as well as significant surface deterioration and structural distresses. If severe or potentially severe joint deterioration from freeze-thaw damage or MRD is present and it exists 3' to 4' beyond joint at nearly every joint, then overlays are not normally a good candidate unless the service life is reduced.

Overlay Selection for Existing Concrete Pavements in Good to Fair Condition



Pavement is structurally sound but has minor surface distresses such as random cracking, and joint spalling.

Pre-Repair Question
Can spot surface repairs and/or spot structural repairs cost effectively solve deficiencies, bring the pavement to "Good Condition," and meet other constraints (i.e., vertical clearance?

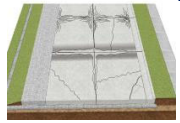
NO

Yes

Bonded Concrete Overlay

Note: Concrete overlay thickness to be designed considering: estimated traffic, desired design life, and budget.

Overlay Selection for Existing Concrete in Pavements in Fair to Poor Condition



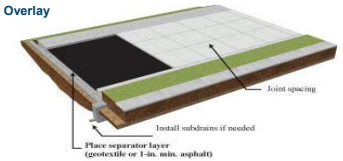
Pavement can exhibit significant surface deterioration and structural distresses

Pre-overlay Questions
Can milling and/or structural repairs, retrofit subdrains, slab stabilization, etc. cost effectively providing uniform base?

NO

Yes

Unbonded Concrete Overlay



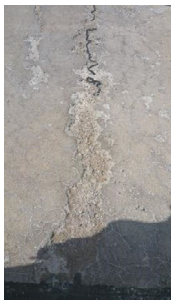
CAUTION About Milling

- Milling should be minimized to retain structural support of pavement
- Preferable to mill to depth that will minimize the potential for delamination between lifts
- Grade corrections should be made in the thickness of the concrete overlay

Excessive milling of existing asphalt beyond asphalt lifts (tack line)

Material Related Distress and Concrete Overlays

If severe or potentially severe joint deterioration from freeze-thaw damage or MRD is present and it exists 3 to 4 ft. beyond the joint at nearly every joint, then the pavement is not normally a good candidate for an unbonded overlay unless the service life is reduced.



Concrete Overlays

The Carolinas' Experience

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GDEAN@PAVEMENTSE.COM

CAROLINAS CONCRETE PAVING ASSOCIATION

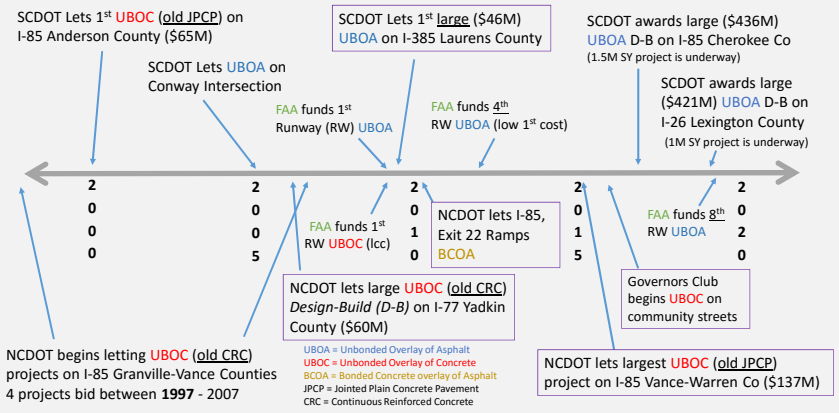
What Types of Concrete Overlays? Experience

North Carolina					South Carolina				
	Bonded Asphalt	Bonded Concrete	UBO Asphalt	UBO Concrete		Bonded Asphalt	Bonded Concrete	UBO Asphalt	UBO Concrete
	THIN		THICK			THIN		THICK	
AIR	N/A	NO	NO	YES (FAA)	AIR	N/A	YES (M)	YES (FAA)	YES (FAA)
S&LR	YES	NO	NO	YES	S&LR	YES	NO	YES	NO
HWY	YES (R)	~~Failed~~	NO	YES	HWY	Yes	NO	YES	YES

NCDOT = 80,000 Center Line Mile System (2nd Largest Maintained)
SCDOT = 41,000 Center Line Mile System (4th Largest Maintained)

UBO = Unbonded Overlay
M = Military Project
FAA = Federal Aviation Admin
R = Ramp Design

Timeline of Concrete Overlay Projects (NCDOT, SCDOT, Airports, ETC)



SCDOT I-385 Laurens County (c2010)

Unbonded Overlay of Asphalt

- Old US Route that had been turned into interstate / Least busiest interstate within SC (2-way ADT = 17,500)
- Official detour – 20 minutes
  - One side (NB) remained shut down
- 14 centerline miles – unbonded overlay (522,000 SY of PCCP)
- Milled 6" existing asphalt
- Resurfaced with 10" JPCP with dowels
  - 8-in RCC shoulder (68,000 SY)

To Greenville SC

I-26 To Columbia SC

SCDOT I -385 Laurens County (c2010)

Unbonded Overlay of Asphalt

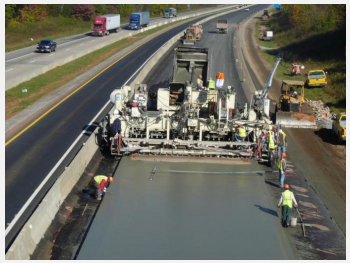
- Concrete psi increased to 5200-psi minimum (from typical 4000-psi)
  - Limits grade change 4-inches
- 26'-wide paving /14' outside lane
- Shifted the crown point to meet Greenbook standards

- Construction commenced 1-2-2010
- Ribbon cutting 7-23-2010; 202 days later

I-77 Yadkin County (c2007)
2009 ACPA Award Winner – Overlay Category

Sep Layer Placement over old CRC
1.5-inch minimum thickness

24-foot wide paving
11-inch Overlay with DBI



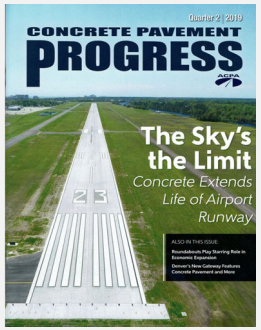
I-77 Yadkin County
Unbonded Overlay of Concrete

Placement of Subslab

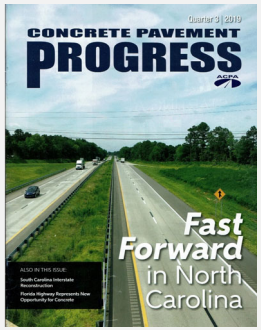
Shifted mainline footprint in areas to avoid "sliver fills" beyond outside shoulders

ACPA Concrete Pavement Progress
2019 Issues (Air / Highway)

http://www.asocatcompublications.com/flipbooks/acpa/2019/Q2/index.html



http://www.acpa.org/19851-2/



http://www.asocatcompublications.com/flipbooks/acpa/2019/Q3/index.html

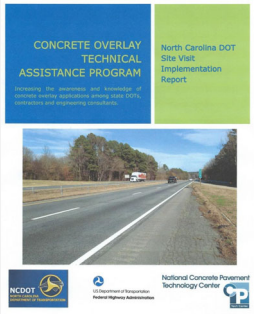
I-85 Vance – Warren Counties
Unbonded Overlay of Jointed Plain Concrete

CP TECH Team Assistance in 2013

- Old (1960's) 9-inch JPCP received band-aid FIX (UTBWC) in 2007
- GPR identified 189 lane-width asphalt patches varying in length between 9.5' to 883' in length (80% < 70-feet)
- Asphalt patches had similar (range of) deflections as adjacent JPCP
- Do the asphalt patches require R&R prior to placement of Sep Layer?

DECISION

- UTBWC and Asphalt Patches Left In-Place prior to Overlay
- 2-inch PADC placed as Sep Layer and Drainage
- Thus, Pre-overlay SAVINGS Estimated at $8M



I-85 Vance – Warren Counties

10-Inch UBO of Jointed Plain Concrete

https://secement.org/promotion-spotlights/

- 21.6 miles, 661,000 Square Yards of New JPCP
- Replacement and Rehab of mainline and Y Line Bridges
- Replacement and Rehab of existing drainage
- Remove and Replace Ramps and Loops
- Accelerated Schedule enabled 1 year earlier completion

7-in Concrete Overlay (c2010) over 8" Binder Base Course, B-25

G A S T O N I A N C

BONDED OVERLAY OF ASPHALT (BCOA)

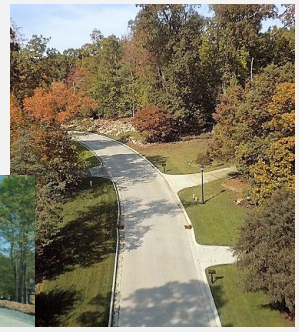
Governors Club Community Streets Rehab

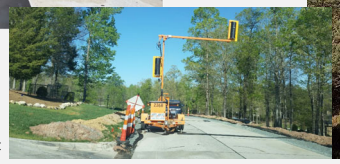
7-inch UBO of Concrete

https://secement.org/promotion-spotlights/

c2016

Geotextile Fabric used as Separation Layer





Traffic Management

The Carolinas' Experience

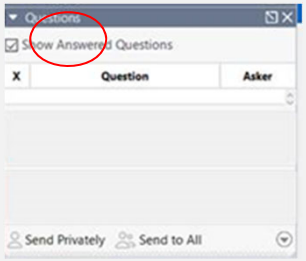
Summary

- ✓Positive experiences with use of Unbonded Concrete Overlays (existing Asphalt & Concrete)
- ✓Agencies & communities benefit from enhanced competition when local airports have used concrete overlays vs asphalt resurfacings (rehabs). Limits reflective cracking, lasts longer!
- ✓Keys to Success
  - ✓Maintenance of Traffic: providing full access to one direction pays dividends. Enables better production, Improved ride, Improved quality and enhanced worker safety!
  - ✓Stringless Paving, Witnessed better performance of Uniform 15-foot joints vs. variable (18 to 22-feet)
- ✓Would like to see state and local agencies use the bonded overlay of asphalt more in the future.
  - ✓6x6x6 overlay technology (6-inch thick, 6x6 panels, bonded to a min 3-inches of asphalt)
- ✓Resiliency benefits of Concrete Overlays need further investigation
  - ✓Can concrete overlays with small elevation increases boost the resiliency of pavements exposed to flood water inundation or prolonged "wet" conditions?

Questions?

Please type questions in the "Question" box

We will provide written answers by email



69