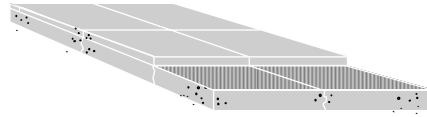


Concrete Overlays Program



Jim Grove
National Concrete Pavement Technology Center



Eight Annual Pennsylvania Concrete Conference
January 31, 2007

Concrete Pavement Overlays

- Interest in PCC overlays has grown tremendously in last decade
- Significant recent research
 - FHWA (ISTEA Section 6005)
 - NCHRP and ACPA Studies
 - State studies
 - LTPP
- ACI-325 is a comprehensive document on overlays but not in user friendly format



Why are we not using Concrete Resurfacing Technology more?

Perception:

- Pavement design theories for bonded and unbonded overlays (resurfacing) are difficult to understand
- There is lack of confidence in overlays because many don't understand how they work




CP Technology Center Advisory Board


- Develop a user friendly “go to” manual with training
 - provide the user with a simple, but educated choice
- Form partnerships between states
 - Share experiences and knowledge
 - Provide assistance
- One single comprehensive document

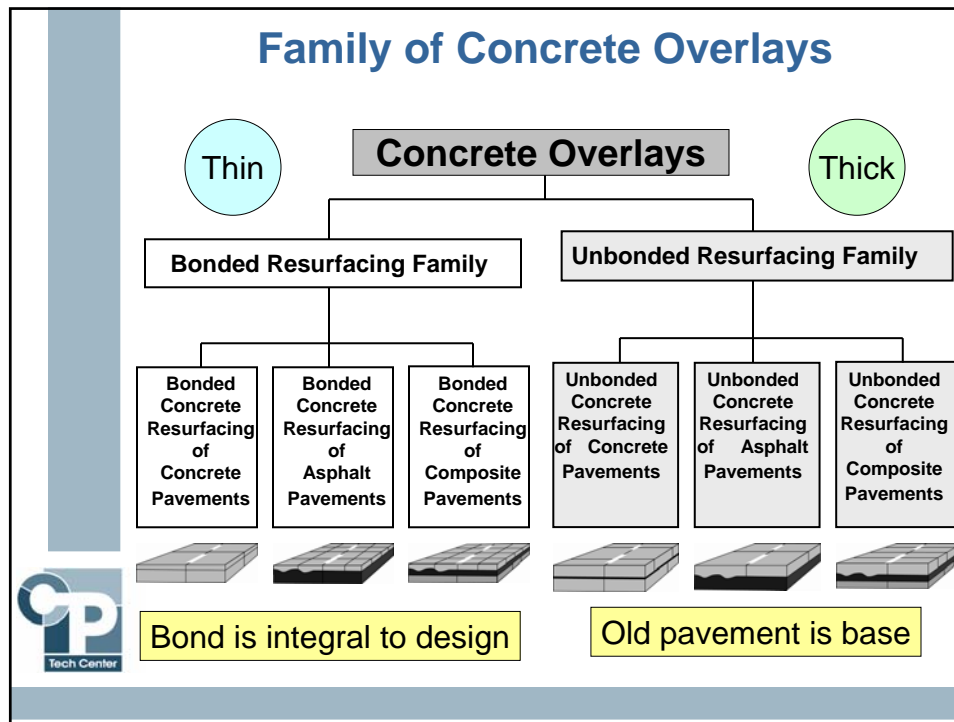


Concrete Overlays Program

	Products	Schedule	Funding
Phase 1. Overlay Guide	28- Guide to Concrete Overlays	2006 develop 2007 print	CP Tech Center
Phase 2. State Projects/ Support	<ul style="list-style-type: none"> □ 8 state projects □ Technical Assistance □ Lessons learned □ Workshops 	2007/2009	FHWA/ISU Cooperative Agreement
Phase 3. Overlay Manual	150+ page overlay manual	2008/2009	Undetermined at this time



- ### Why Concrete Overlays?
- #### Advantages
- Do not require extensive repairs of existing pavement
 - Quick to construct
 - Long performance lives
 - Low maintenance requirements
 - Withstands heavy truck traffic
 - Effective life-cycle costs
 - Recyclable
- 



Evaluations of Existing Pavements for Overlays

- Evaluation establishes if pavement is a good candidate for an Overlay
 - Can it provide an uniform and stable support system?
 - Surface deflects can be overcome
 - Does the condition of the pavement fit the type of Overlay proposed?
 - Is the existing slab or joints moving?
 - When combined with an Overlay can the existing pavement help carry anticipated traffic as
 - An integrated part of the pavement (bonded)
 - Serve as a base or subbase (unbonded)

Evaluations of Existing Pavements for Overlays

- Evaluation is also used to determine:
 - Required repairs where needed
 - Establish the concrete overlay design thickness
- The condition of the existing concrete pavement can be initially assessed through
 - A visual examination of any existing distresses
 - Analysis of cores



Pavement Evaluation

- Falling weight deflectometer (FWD) testing can provide
 - Subgrade k-values
 - Variability
 - Concrete modulus
 - Load transfer efficiency
 - Presence of voids
- Normally high volume roads



Bonded Resurfacing Family

- Thin Overlays
- Over concrete, asphalt, and composites
- Bond is critical !

```

graph TD
    A[Bonded Resurfacing Family] --> B[Bonded Concrete Resurfacing of Concrete Pavements]
    A --> C[Bonded Concrete Resurfacing of Asphalt Pavements]
    A --> D[Bonded Concrete Resurfacing of Composite Pavements]
    
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Uses and Advantages Bonded Concrete

- When existing pavement is in good structural condition- some surface distress
- Use to
 - Increase structural capacity
 - Improve surface friction, noise, rideability

Bonded overlay

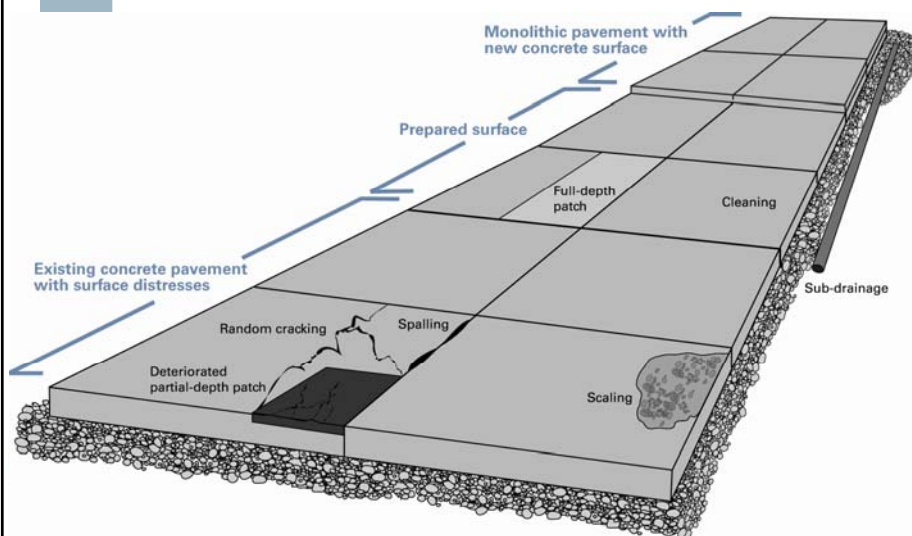
Uses and Advantages Bonded Concrete

- Typically used directly over concrete without additional repairs except for spot-repairing of severely deteriorated areas
- Working cracks in existing pavement will reflect through
- Can used in conjunction with widening




Evaluation

Bonded Concrete

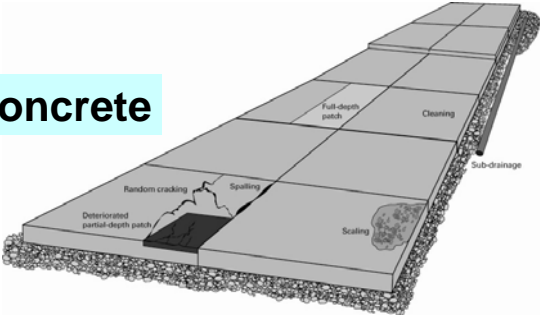


Evaluation Bonded | Concrete


- Evaluate the severity and extent of distresses to determine if a bonded overlay is appropriate
- If not widespread, repairs should be made before placement of the overlay
- If significant repairs are needed, probably not a good candidate



Repairs Bonded | Concrete



Existing pavement distress	Spot repairs to consider
Random cracks	Reflective cracking is likely if no repairs are made. Use crack cages or full-depth repairs for severe cracks.
Faulting	Slab stabilization
Pumping	Slab stabilization
Asphalt patch	Replace with concrete patch to ensure bonding.
Joint spalling	Partial-depth repair
Scaling	Remove with cleaning.



Milling

Bonded | Concrete

- Used to lower profile only
 - Urban streets with curb
- Use up-milling to minimize micro cracking
- Micro cracks need to be removed
 - Cracks can break the bond
- Shotblast or high water pressure



Surface Preparation for Bonding

Bonded | Concrete

Milling



Shotblasting



Cleaning the Surface to Prepare for Bonding

- Sweeping surface followed by compressed air cleaning in front of the paver
- Water or moisture should not be on the surface prior to paving or de-bonding can occur

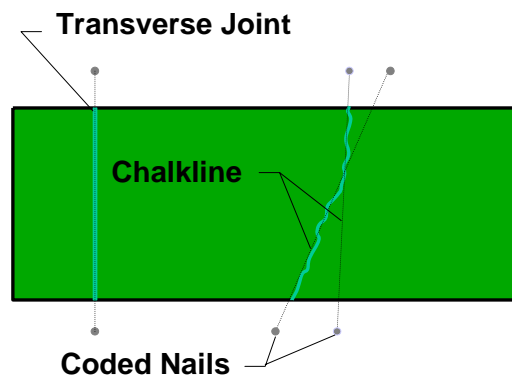


Jointing

Bonded | Concrete

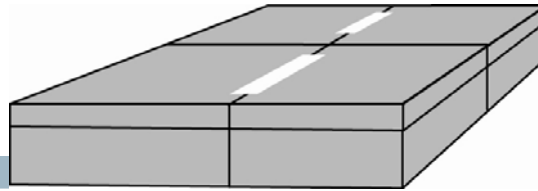
Marking

- Use Chalklines
- Mark all joints
- Mark all cracks



Important Elements Bonded Concrete

- A clean surface, which leads to good bond, is critical for good performance as a monolithic pavement
- Concrete aggregate used should have thermal properties similar to that of existing pavement to minimize shear stress at the bond interface



Important Elements Bonded Concrete

- Timing of joint sawing is very important
- Matching joints with underlying pavement allows structure to move monolithically
- 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
 - The risk of early-age cracks is higher



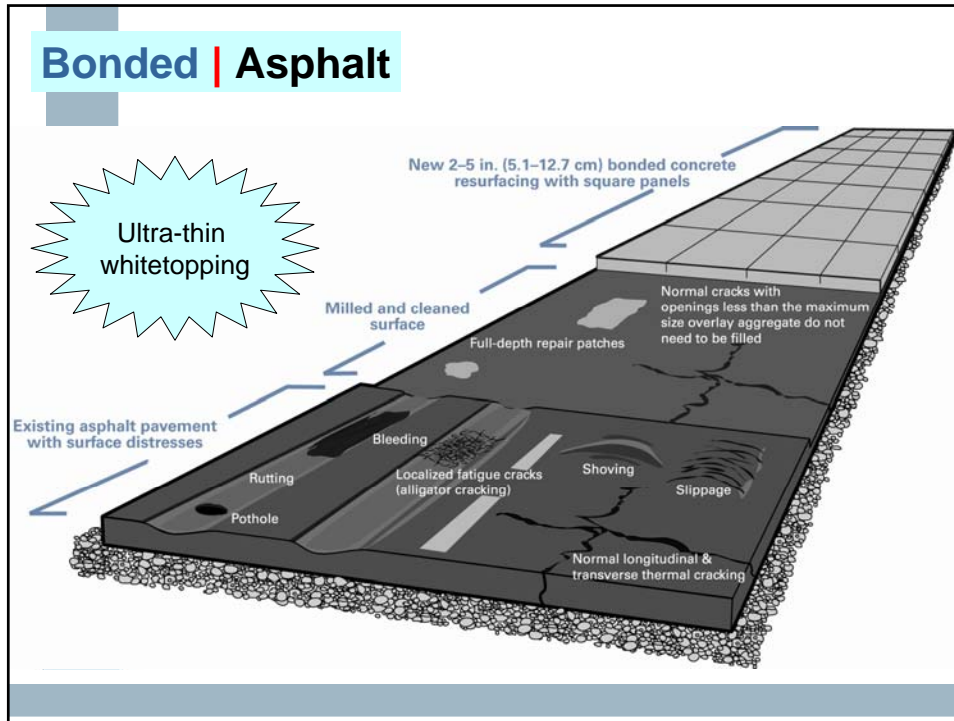
Uses and Advantages Bonded | Asphalt or Composite

2"-5" thickness

- Use when existing pavement is in good to fair structural condition but has surface distress
- Use to
 - Eliminate any surface defects
 - Increase structural capacity
 - Improve surface friction, noise, and rideability

Uses and Advantages Bonded | Asphalt or Composite

- Can be used directly over asphalt without additional repairs except for minor milling
- Cracks in existing HMA pavement will not reflect through
- Can be used in conjunction with widening



Evaluation Bonded | Asphalt

- Localized areas of weakness can be strengthened through patching
- Milling can remove a number of asphalt surface distresses
- Condition of the underlying HMA greatly influences performance

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Effects of Joint Spacing Bonded | Asphalt

3.0 ft 3.0 ft 3.0 ft 10.0 ft

Short joint spacing allows the slabs to deflect instead of bend. This creates the need to balance thickness and joint spacing.

Tech Center

Bonded | Composite

Existing composite pavement with asphalt surface distresses

Pothole

Rutting

Bleeding

Localized fatigue cracks (alligator cracking)

Shoving

Slippage

Normal longitudinal & transverse thermal cracking

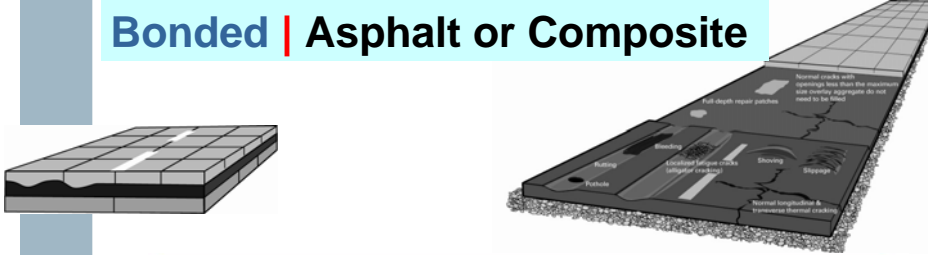
Milled and cleaned surface

Full-depth repair patches


Normal cracks with openings less than the maximum size overlay aggregate do not need to be filled

New 2-5 in. (5.1-12.7 cm) thick bonded resurfacing with square panels

Repairs Bonded | Asphalt or Composite





Existing pavement distress	Spot repairs to consider
Fatigue cracking	Full-depth repair patch
Pothole	Full-depth repair patch
Deep rutting	Milling
Shoving, slippage	Milling
Thermal cracking	None



Milling Bonded | Asphalt or Composite

- The three main objectives of milling prior to a bonded resurfacing are
 - to remove significant surface distortions
 - to reduce high spots
 - Help ensure minimum resurfacing depth
 - Reduce the quantity of concrete needed to fill low spots
 - to roughen the surface to enhance bond
- Milling should be minimized because it removes existing pavement structure

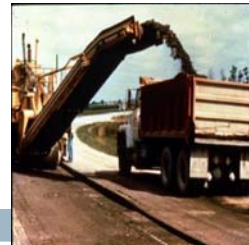
Milling Bonded | Asphalt or Composite Unbonded | Asphalt or Composite

- The amount of removal depends on
 - The types and severity of distresses
 - The thickness of the asphalt pavement
- The objective of removing material
 - Not to obtain a perfect cross section
 - Not necessary to completely remove ruts
 - Usually 1"–2" of asphalt is removed
- A minimum of 3"–4" of asphalt should be left after milling
 - The design depends on the asphalt pavement to carry a portion of the load



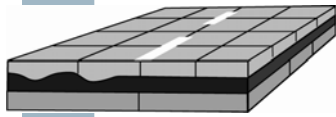
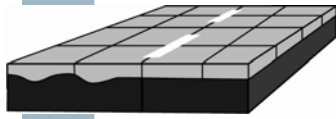
Milling Bonded | Asphalt or Composite Unbonded | Asphalt or Composite

- Direct placement without milling is recommended when rutting in the existing asphalt pavement does not exceed 2"
- Not milling out the ruts result in filling them with concrete, thereby thicker concrete in the wheel path
- Used with inlays
 - Limited vertical clearances



Important Elements

Bonded | Asphalt or Composite

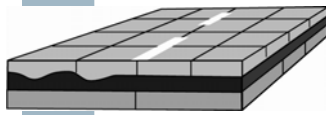
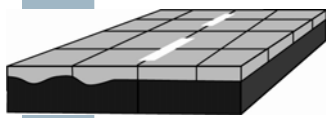


- Clean surface-bond is critical
- Thin milling may be required to eliminate significant surface distortions of 2" or more
- Milling enhances bond
- Leave at least 3" remaining asphalt after milling



Important Elements

Bonded | Asphalt or Composite

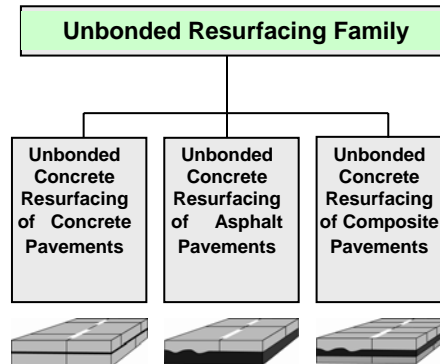


- Control surface temperature of existing asphalt to below 120°F
- Try to keep joints out of wheel paths
- Curing should be timely and adequate
- Small joint spacing to minimize curing and warping



Unbonded Resurfacing Family

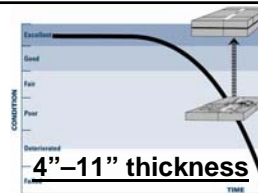
- Thicker overlays- real pavement
- Over concrete, asphalt, or composite
- Bond is not considered in the design
- Bonding is still good!

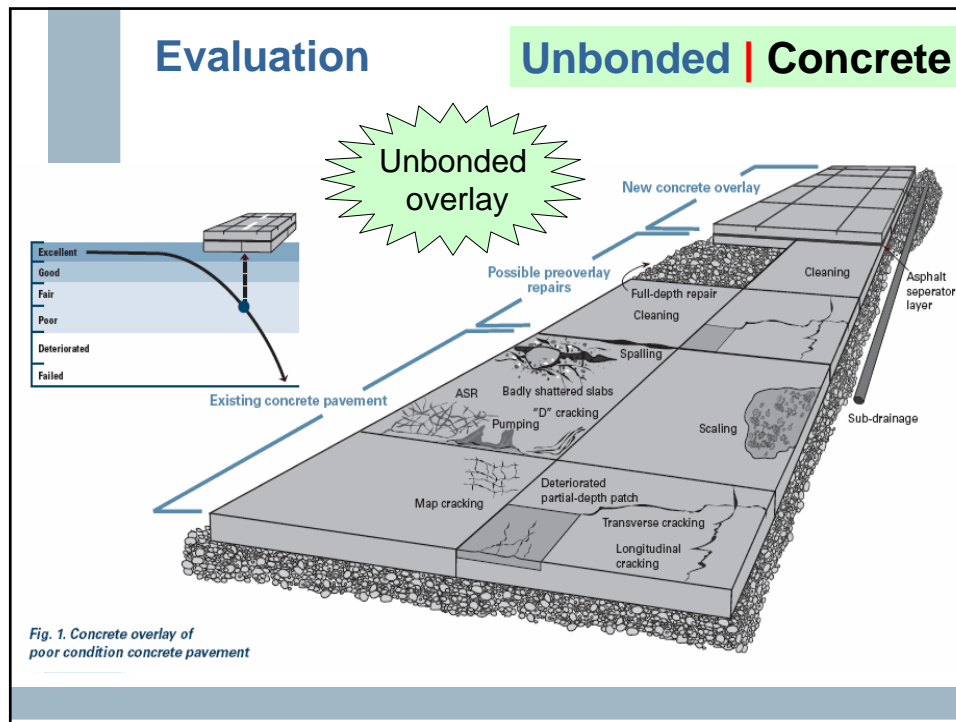


Uses and Advantages

Unbonded | Concrete

- Use when
 - Existing pavement is in poor condition
 - The underlying pavement and subbase are stable and uniform
- Use to restore structural capacity of the existing pavement
- Increase pavement life
 - Often equivalent to full-depth pavement
- Used to improved surface friction, noise, and rideability






Evaluation **Unbonded | Concrete**

- The evaluation establishes whether the existing concrete and its subbase can provide a uniform strength platform and, if not, what actions are necessary to obtain that uniformity
- Look for events of movement in the slab
 - Profile is a good check

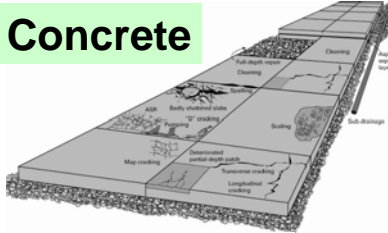
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Evaluation Unbonded | Concrete


- If the movement is confined to isolated areas, a full depth patch can solve the problem
- For faulted pavements, if the subgrade is stable, the overlay has proven to be adequate
- Faulting is generally not a concern when a separator layer of 1" or greater is used



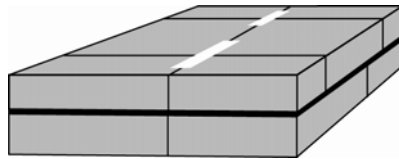
Repairs Unbonded | Concrete



Existing pavement condition	Possible repairs to consider
Faulting 1/4" to 3/8"	None
Faulting >3/8"	Thicker separator layer; see step 2
Significant tenting	Full-depth repair
Badly shattered slabs	Full-depth repair
Significant pumping	Full-depth spot repair and improve drainage
Severe joint spalling	Clean
CRCP with punchouts or other severe damage	Full-depth repair



Important Elements Unbonded | Concrete



- Full-depth repairs are required only where structural integrity is lost at isolated spots
- Asphalt separator layer is important to isolate unbonded resurfacing from underlying pavement and minimize reflective cracking



Important Elements Unbonded | Concrete

- Faulting (<math><3/8\text{''}</math>) is generally not a concern when the asphalt separation layer is 1"
- With heavy truck traffic, adequate drainage design may be important to reduce pore pressure
- Shorter joint spacing helps minimize curling and warping stresses
- No need to match joints with those of the underlying concrete pavement



Uses and Advantages

Unbonded | Asphalt or Composite

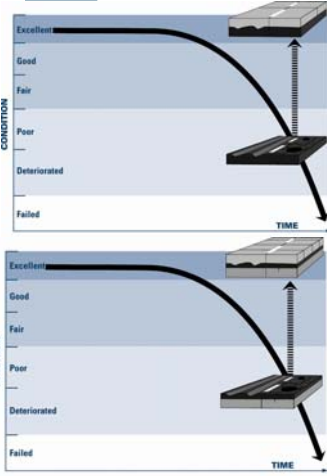
- Use when existing pavement is deteriorated condition
 - Severe rutting
 - Potholes
 - Alligator cracking
 - Shoving and pumping
 - Exhibits past D-cracking and ASR

Uses and Advantages

Unbonded | Asphalt or Composite

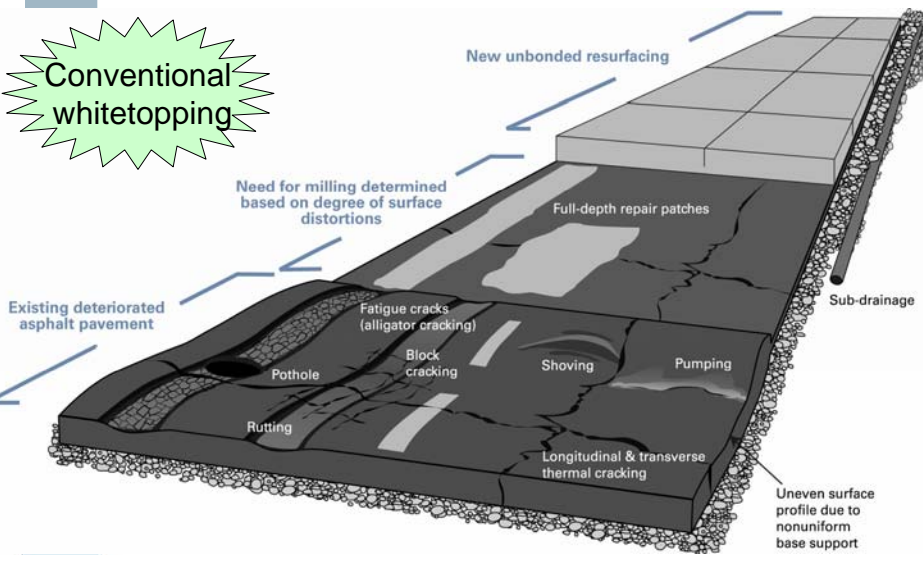
- Used when underlying pavements and subbase are stable and uniform except for isolated areas that can be repaired
- Use to restore structural capacity of the existing pavement

Uses and Advantages Unbonded | Asphalt or Composite



- Used to increase pavement life equivalent to full-depth pavement
- Eliminates rutting and shoving problems and results in improved surface friction, noise, and rideability

Unbonded | Asphalt



Conventional whitetopping

Existing deteriorated asphalt pavement

Need for milling determined based on degree of surface distortions

New unbonded resurfacing

Full-depth repair patches

Sub-drainage

Pothole

Rutting

Fatigue cracks (alligator cracking)

Block cracking

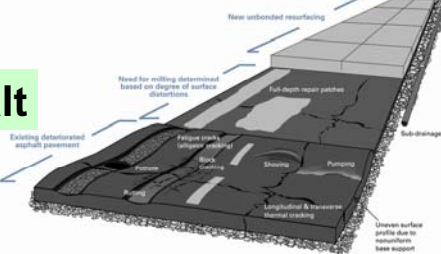
Shoving

Pumping

Longitudinal & transverse thermal cracking

Uneven surface profile due to nonuniform base support

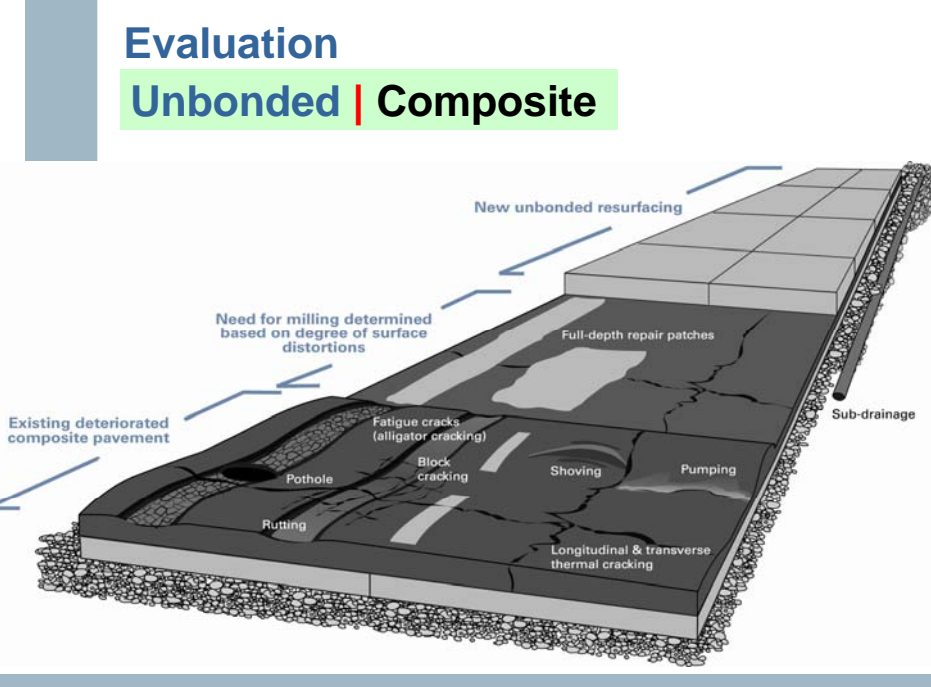
Evaluation Unbonded | Asphalt



The diagram illustrates a cross-section of an asphalt pavement structure. On the left, it shows 'Existing deteriorated asphalt pavement' with various distresses: 'Fatigue cracks (alligator cracking)', 'Block cracking', 'Pothole', 'Rutting', and 'Longitudinal & transverse thermal cracking'. A 'Sub-drainage' pipe is shown at the bottom right. In the center, 'Full-depth repair patches' are shown. On the right, 'New unbonded resurfacing' is shown as a new layer on top. Labels include 'Need for milling determined based on degree of surface distortions', 'Pumping', and 'Uneven surface profile due to nonuniform base support'. A 'Tech Center' logo is in the bottom left corner.

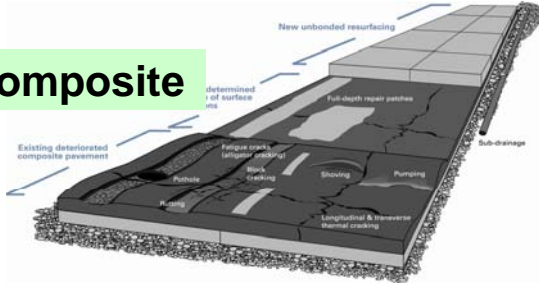
- Identify isolated spots of heavy distress
- Determine the existing pavement
 - Structural contribution
 - Foundation support
- Localized areas of weakness can be strengthen through patching
- Milling can remove a number of asphalt surface distresses

Evaluation Unbonded | Composite



The diagram illustrates a cross-section of a composite pavement structure. On the left, it shows 'Existing deteriorated composite pavement' with various distresses: 'Fatigue cracks (alligator cracking)', 'Block cracking', 'Pothole', 'Rutting', and 'Longitudinal & transverse thermal cracking'. A 'Sub-drainage' pipe is shown at the bottom right. In the center, 'Full-depth repair patches' are shown. On the right, 'New unbonded resurfacing' is shown as a new layer on top. Labels include 'Need for milling determined based on degree of surface distortions', 'Pumping', and 'Uneven surface profile due to nonuniform base support'. A 'Tech Center' logo is in the bottom left corner.

Evaluation Unbonded | Composite



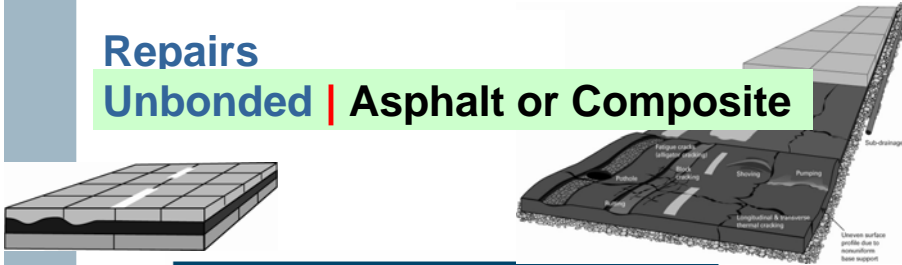
- If there is evidence of movements, detailed pavement analysis is needed
- If the movement is confined to isolated areas, a full-depth repair of the area should be considered

Evaluation Unbonded | Composite


- Tented panels with significant movement
 - Can be repaired to relieve the pressure
 - Can provide uniform support before construction
- Faulted panels (that do not exhibit continuing movement) have proven to provide adequate support
- Edge drains have also been successfully used to reduce the progression of faulting

Repairs

Unbonded | Asphalt or Composite

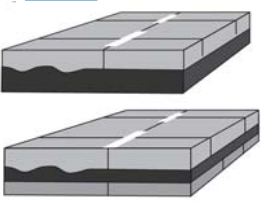


Existing pavement condition	Possible repairs to consider
Area of subgrade failure	Remove and replace with stable material
Severe distress that results in variation in strength of asphalt	Remove and replace with stable material
Potholes	Fill with lean or plain concrete or asphalt
Shoving	Mill
Rutting $\geq 2"$	Mill
Rutting $< 2"$	None or mill
Cracking $\geq 4"$	Fill with lean concrete
Cracking $< 4"$	None




Important Elements

Unbonded | Asphalt or Composite



- Full-depth repairs
 - Only where structural integrity is lost at isolated spots
- Mill only severe surface distortions
- Cracks in the asphalt will not reflect up

WHY?



Important Elements
Unbonded | Asphalt or Composite

Concrete overlay movement dominates the old asphalt!

Important Elements
Unbonded | Asphalt or Composite

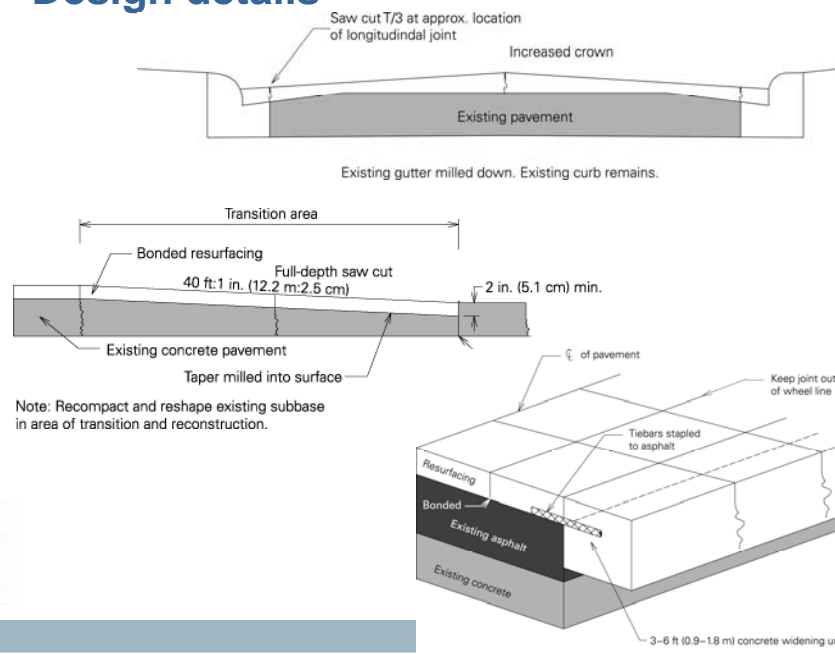
- Examine profile for distortion at joints.
- Existing asphalt serves as separator layer.
- Slightly shorter Joint spacing than normal
- Timing of the joint sawing is important
 - Particularly for thinner resurfacing

Joint Sawing

	Bonded Resurfacing		Unbonded Resurfacing	
	PCC	HMA	PCC	HMA
Transverse joint saw-cut depth for conventional saws	Full depth + 1/2"	T/4	T/4 min. – T/3 max.	
Transverse joint saw-cut depth for early-entry saws	Full depth + 1/2"	Not < 1-1/4"	Not < 1-1/4"	
Longitudinal joint-saw-cut depth	T/2 (at least)	T/3	T/3	



Design details



National Concrete Pavement Technology Center



For more information,
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