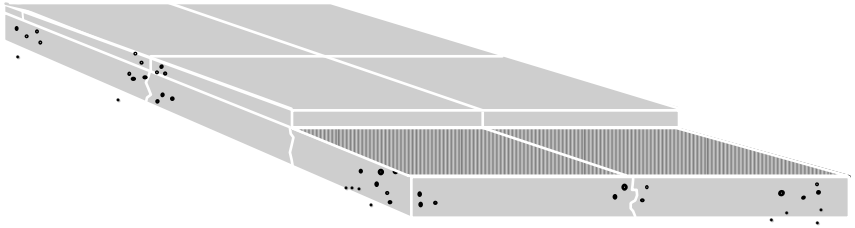
Concrete Overlays



Northwest Pavement Management Association 2011Conference

Jim Powell, P.E.

Concrete Pavement Overlays

- Use of 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 Concrete Overlays?

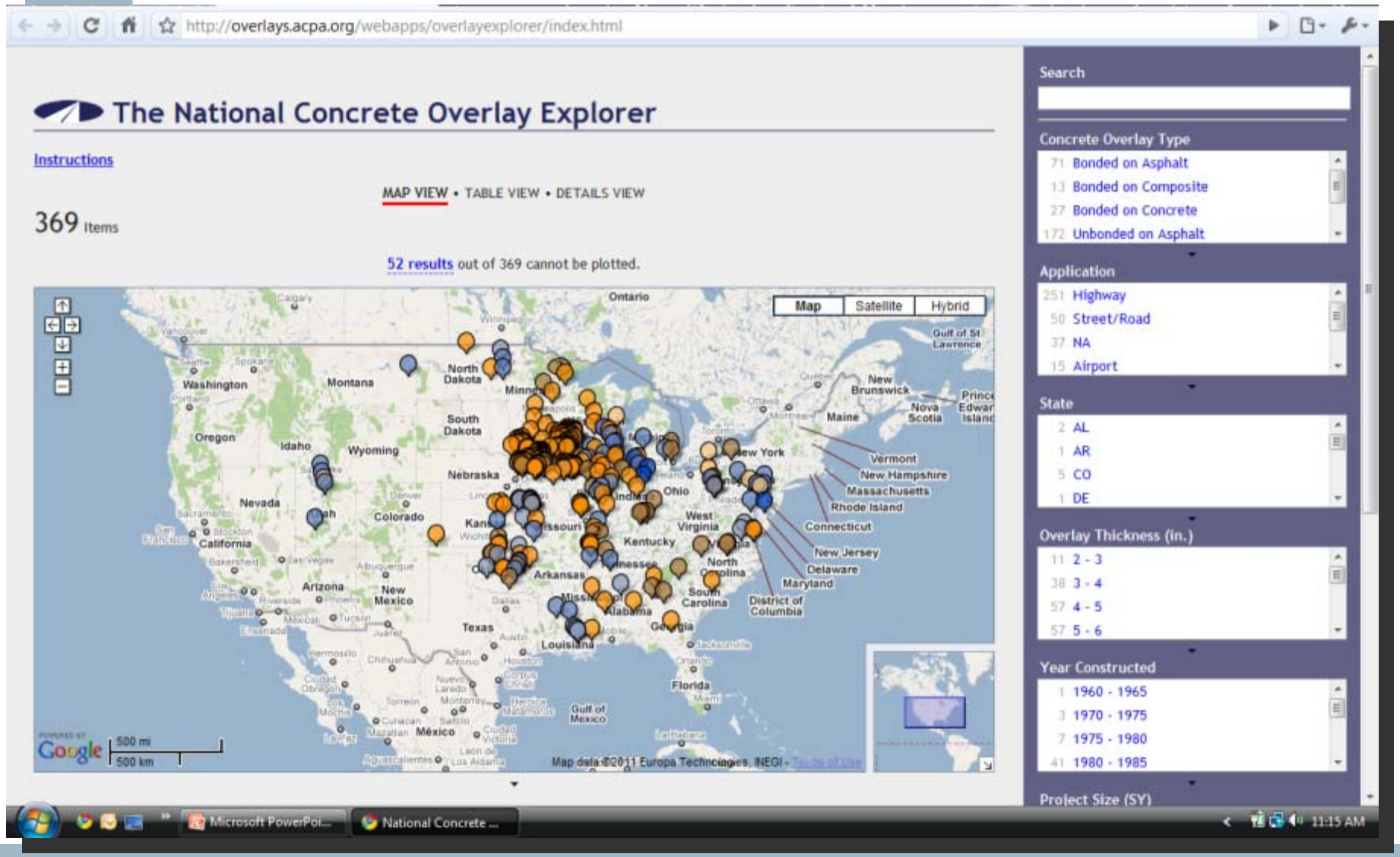
- Does not require extensive repairs of existing pavement
- Long performance life
- Low maintenance requirements
- High load-carrying capacity
- Withstands heavy truck traffic
- Effective life-cycle costs

National Concrete Overlay Database

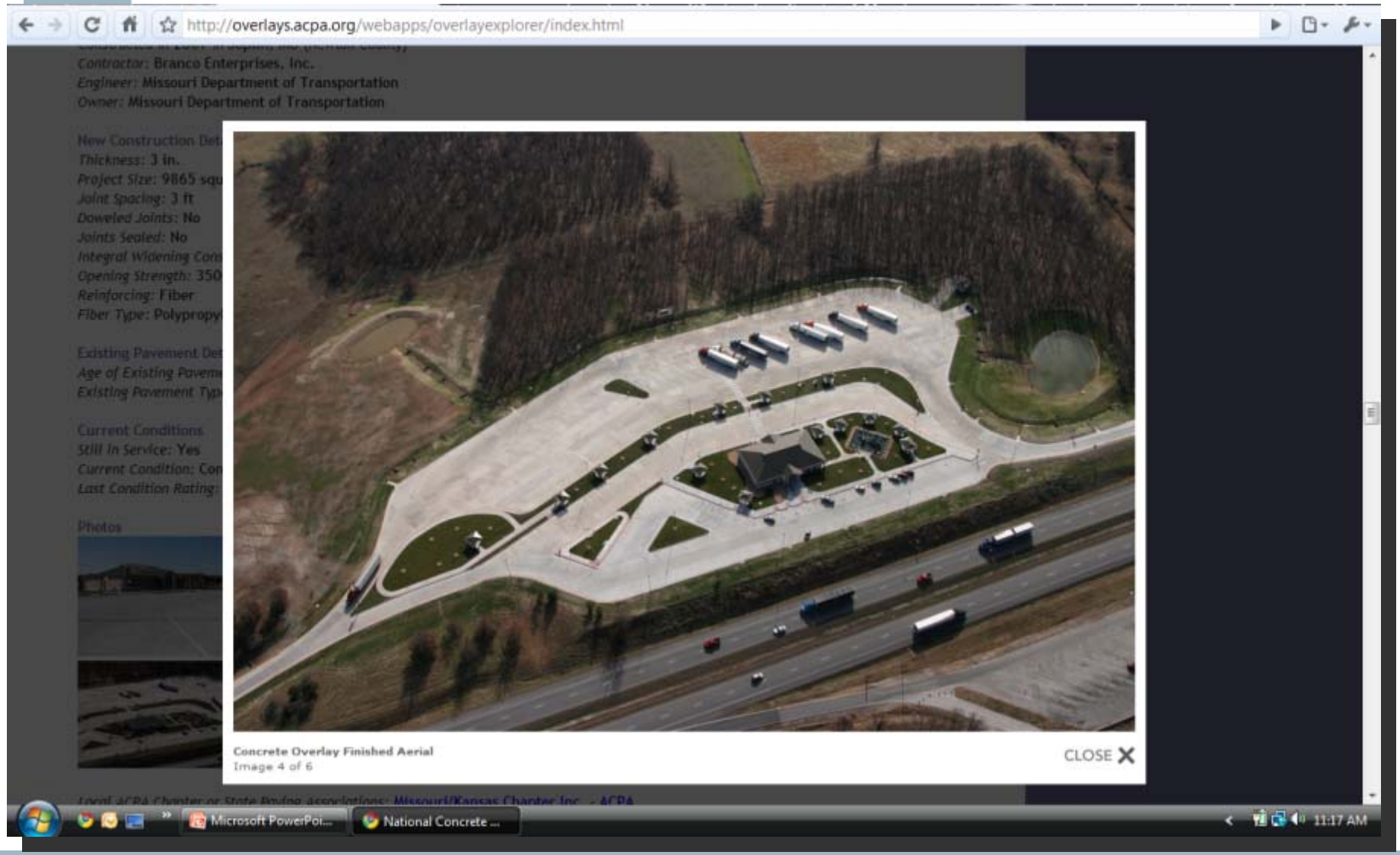
- Consult the National Overlay Explorer App on the ACPA website.
- Data on many projects.

View @ http://apps.acpa.org/apps/Overlaypass.html

National Concrete Overlay Explorer

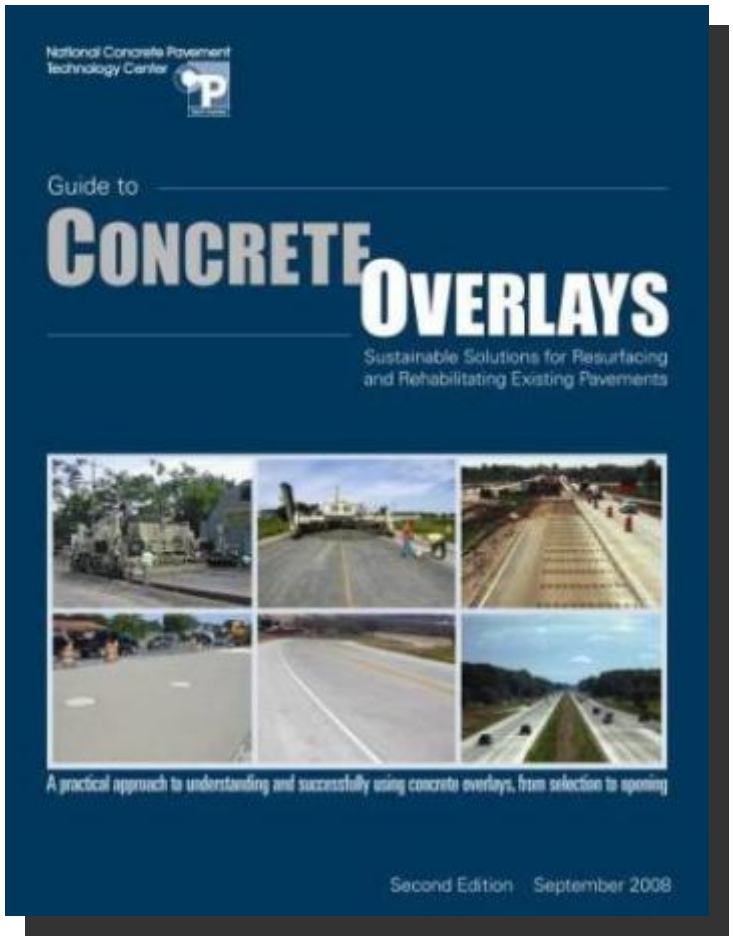


National Concrete Overlay Explorer



Concrete Overlay Guide, 2nd Edition

- Overview of Overlay Families
- Overlay types and uses
- Evaluations & Selections
- Six Overlay Summaries
- Design Section
- Miscellaneous Design Details
- Overlay Materials Section
- Work Zones Under Traffic
- Key Points for Construction
- Accelerated Construction
- Specification Considerations
- Repairs of Overlays



Second Edition September 2008

Family of Concrete Overlays

Thinner

Concrete Overlays

Thicker

Bonded Resurfacing Family

Unbonded Resurfacing Family

Bonded Concrete Resurfacing of Concrete Pavements

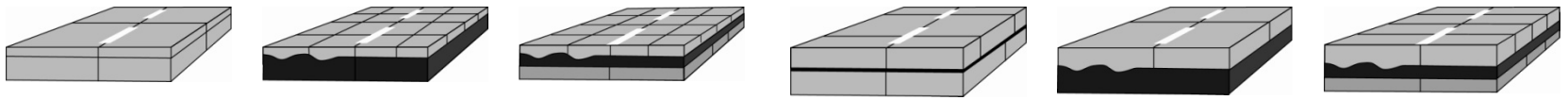
Bonded Concrete Resurfacing of Asphalt Pavements

Bonded Concrete Resurfacing of Composite Pavements

Unbonded Concrete Resurfacing of Concrete Pavements

Unbonded Concrete Resurfacing of Asphalt Pavements

Unbonded Concrete Resurfacing of Composite Pavements



Bond is integral to design

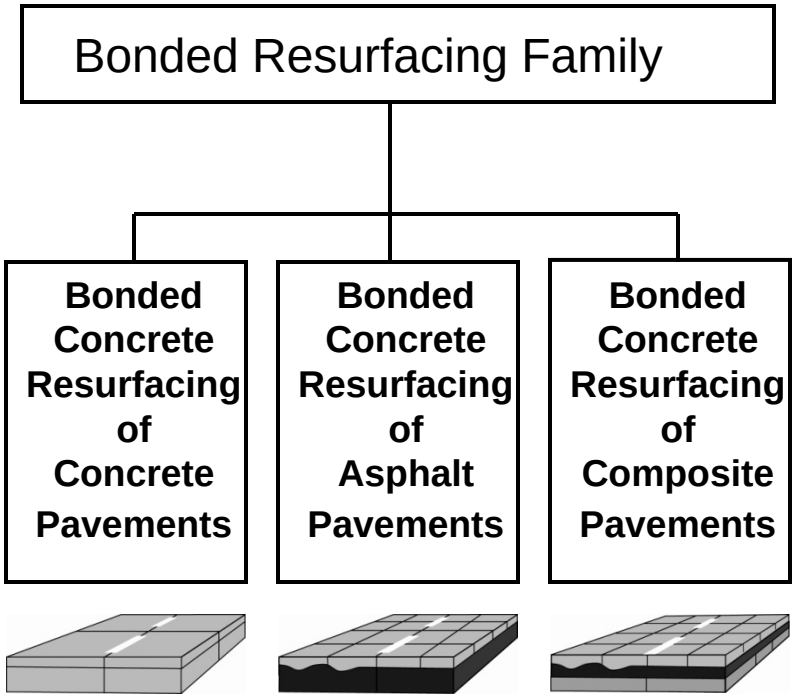
Old pavement is base

Evaluations of Existing Pavements for Overlays

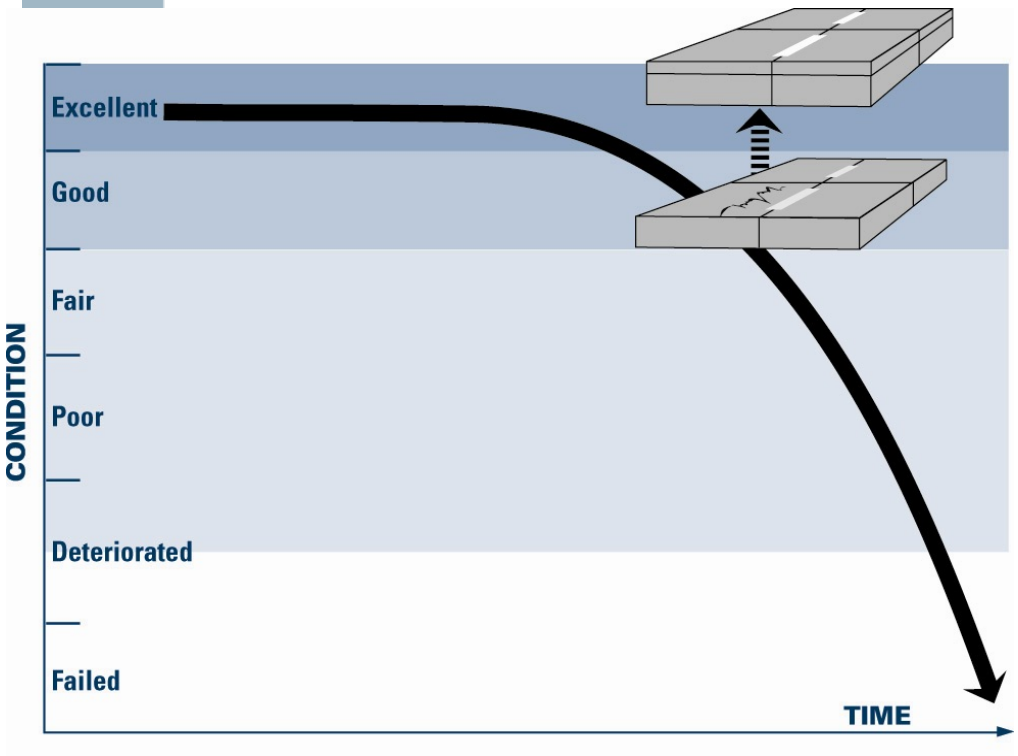
- Evaluation establishes if existing pavement is a good candidate for an overlay.
  - ✓ The condition of the existing concrete pavement can be initially assessed through:
    - a visual examination of the type, severity, and extent of existing distresses.
    - Concrete material condition can be obtained through analysis of cores taken from the existing pavement.
  - ✓ Can it provide an uniform and stable support system for the overlay?
    - Surface deflects can be overcome.
    - Does the condition of the pavement fit the type of overlay proposed?
    - Is the existing slab or joints moving?

Bonded Resurfacing Family

- Thin Overlays (2” – 5”)
- Over concrete, asphalt, and composites
- Bond is critical



Uses and Advantages- Bonded Resurfacing of Concrete



2”–5” thickness

- Use when existing pavement is in good structural condition with some surface distress.
- Use to eliminate any surface defects; increase structural capacity; and improve surface friction, noise, and rideability.

- 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.

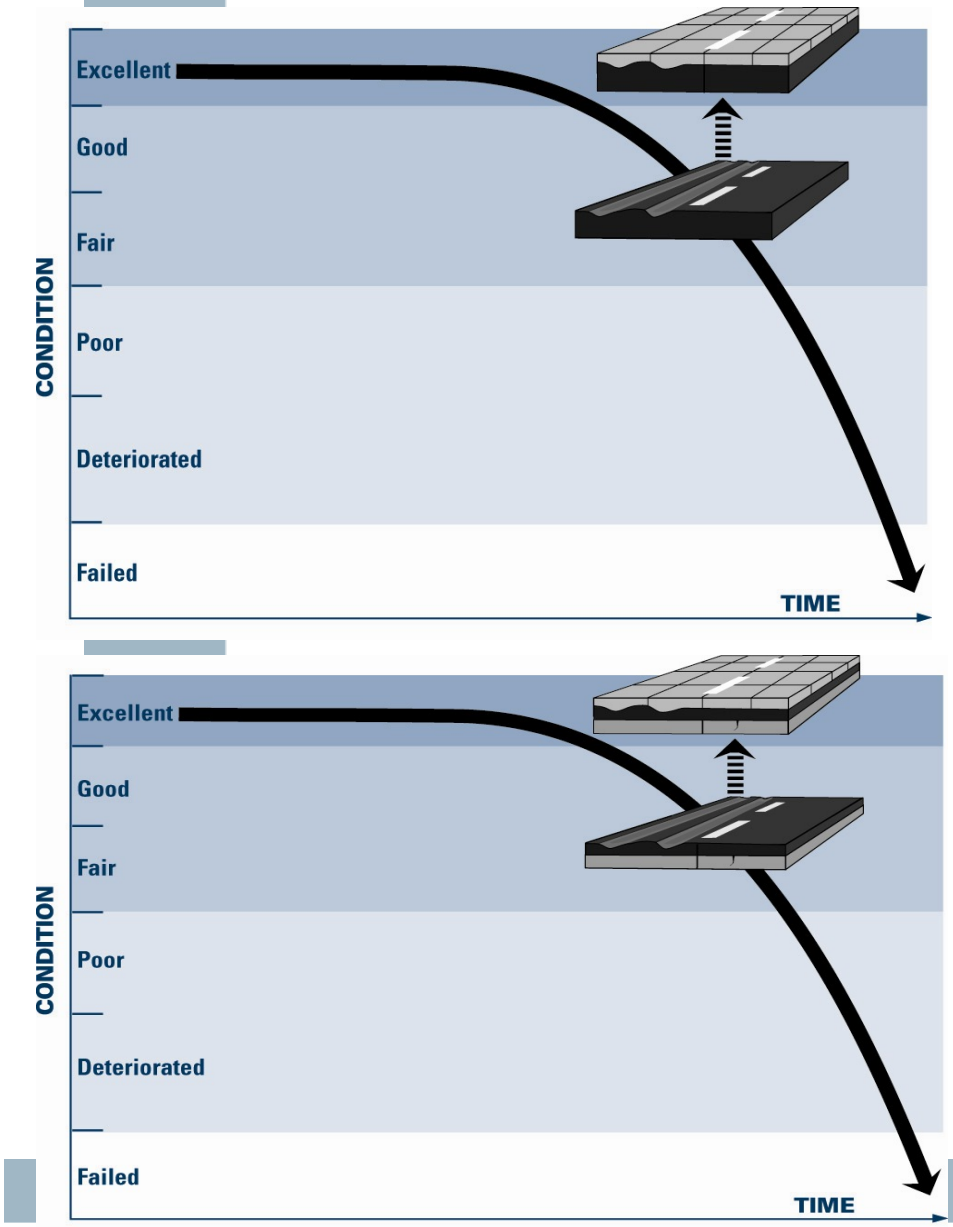
Whitetopping - History

- First Whitetopping
  - South 7th street in Terre Haute, Indiana - 1918
  - Existing flexible pavement was overlaid with 3 - 4 in. of reinforced concrete
- During 40's and 50's -
  Used to upgrade military & civil airports
- Highway use
  - Started approx. 1960
  - Types have included JPCP, JRCP, CRCP, FRC

Whitetopping History

- Began in Iowa in 1960’s as overlay on farm to market asphalt roads
- Thickness greater than 4”
- Performance was excellent
- Bonding to asphalt layer was noticed

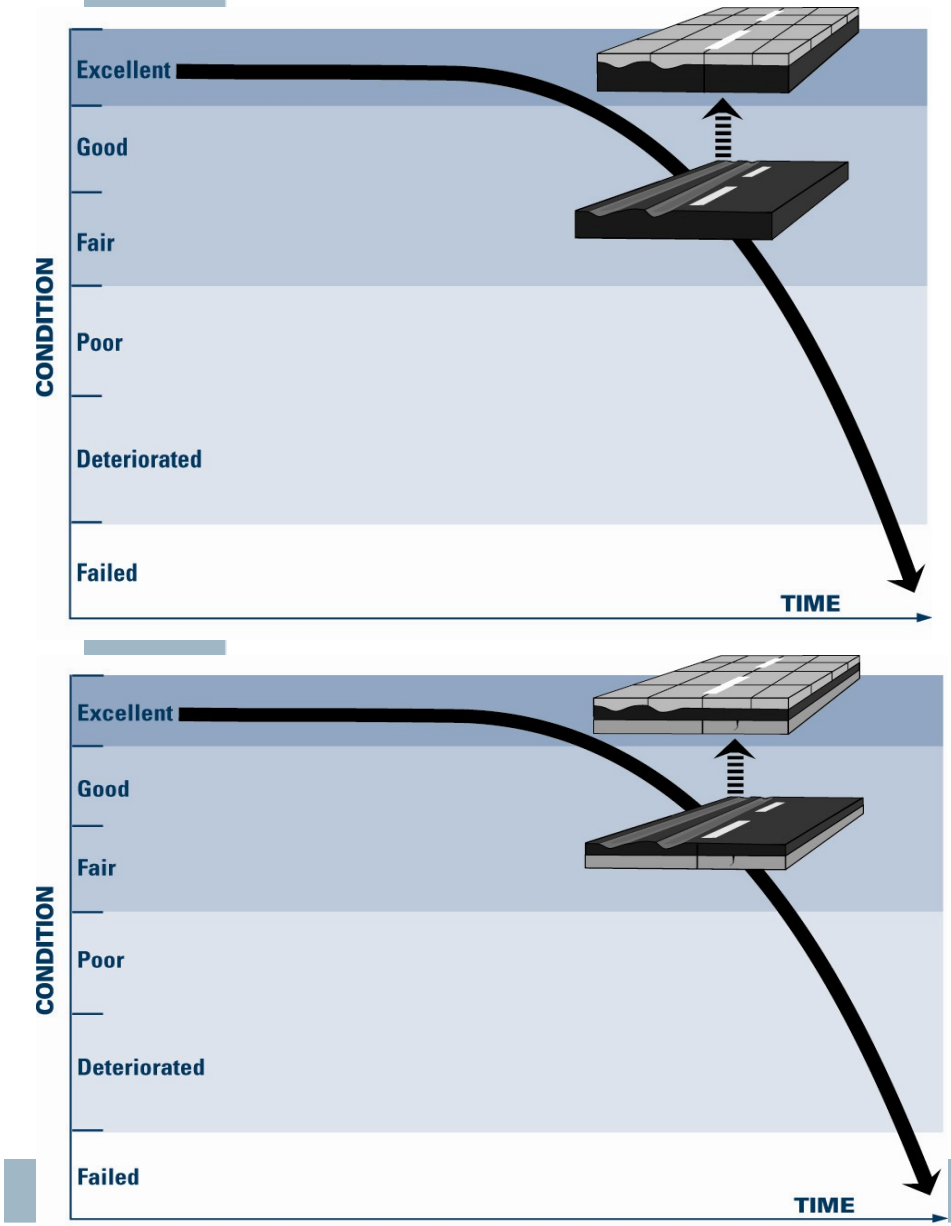
Uses and Advantages- Bonded Resurfacing of Asphalt or Composite Pavements



2”–5” thickness

- Use when existing pavement is in fair or better structural condition with surface distress.
- Use to eliminate any surface defects; increase structural capacity; and improve surface friction, noise, and ride.

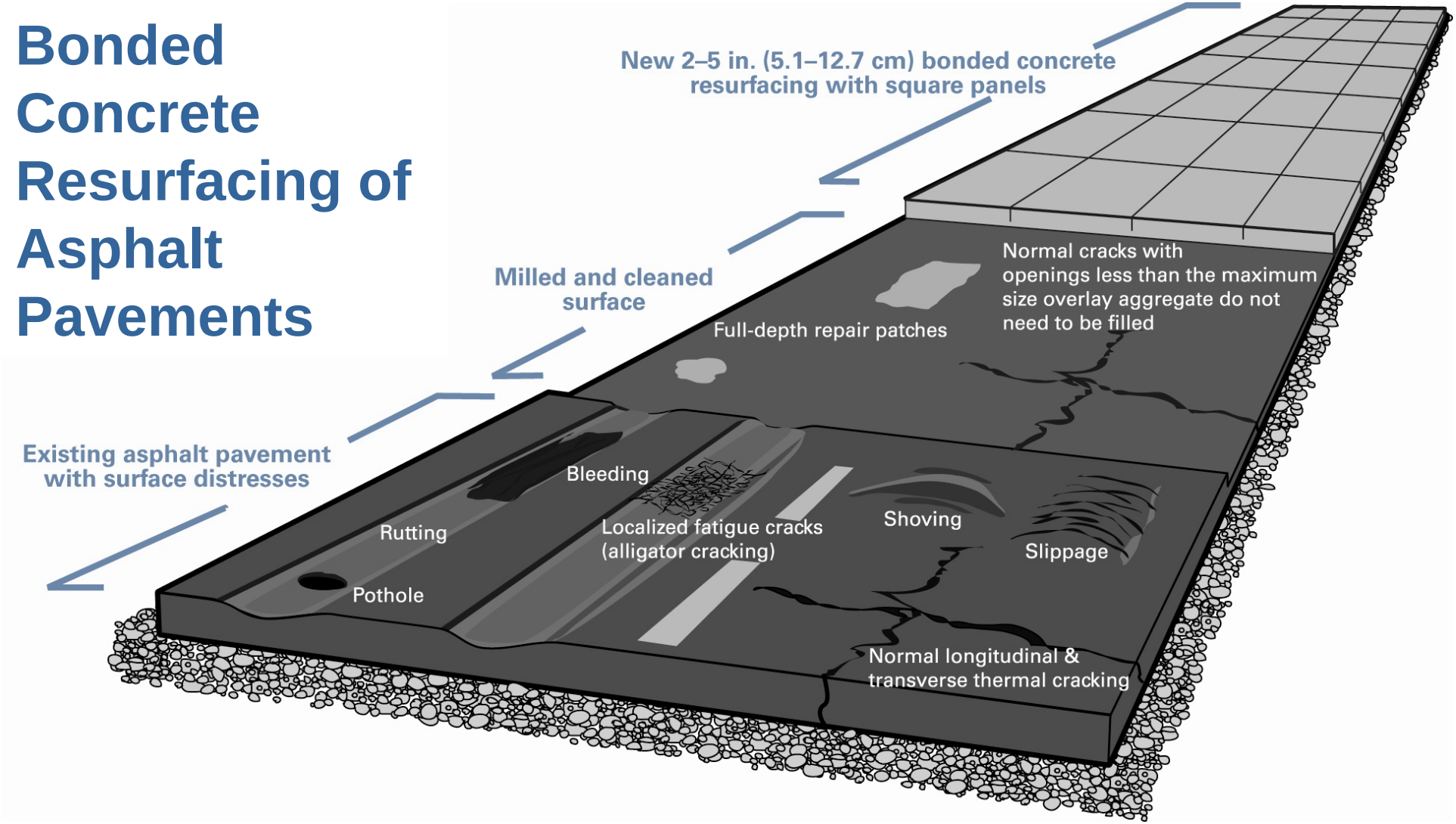
Uses and Advantages- Bonded Resurfacing of Asphalt or Composite Pavements



2”–5” thickness

- Typically used directly over asphalt without additional repairs except for minor milling.
- Working cracks in existing pavement will not reflect through.
- Can used in conjunction with widening.

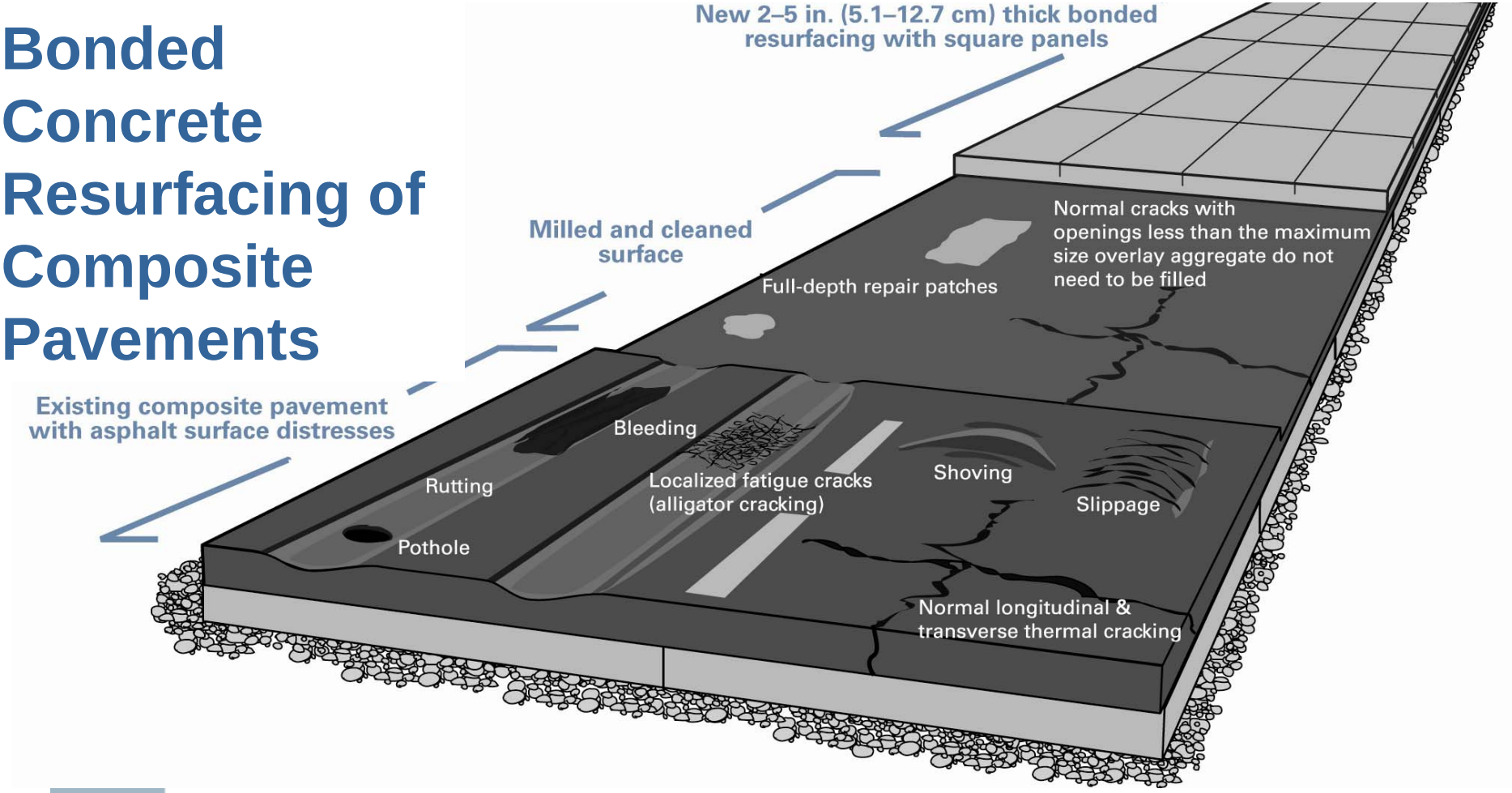
Bonded Concrete Resurfacing of Asphalt Pavements



- Spots of distress that aren't visible can be determined through evaluation such as the stiffness of the asphalt pavement and subgrade support conditions.

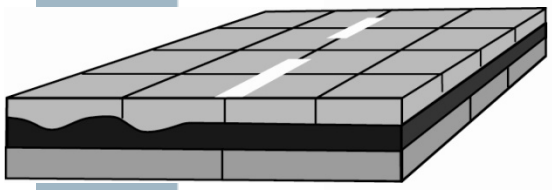
- Localized areas of weakness can be strengthen through patching. Milling can remove a number of asphalt surface distresses.

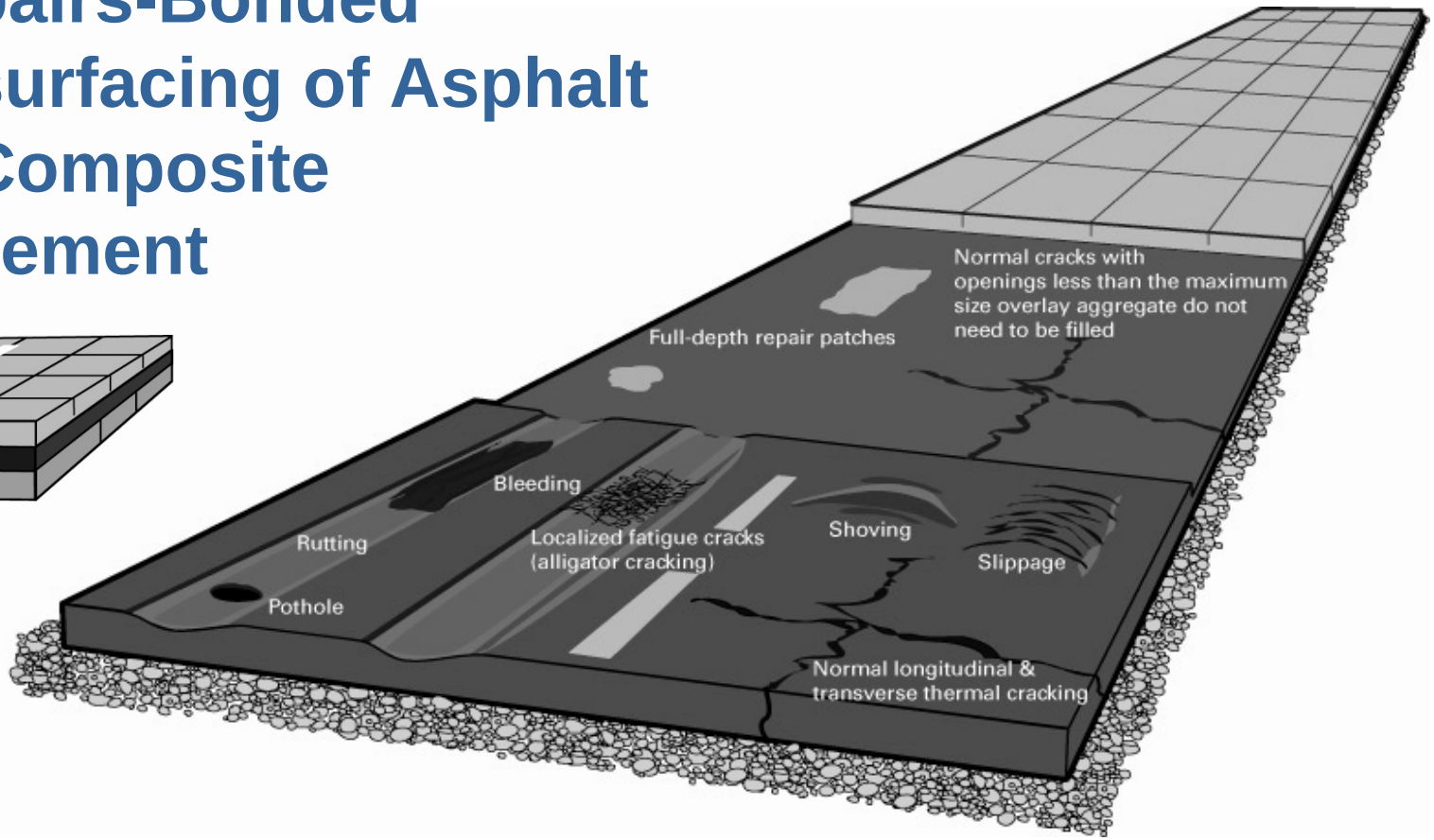
Bonded Concrete Resurfacing of Composite Pavements



- Asphalt is a good reflector of underlining concrete pavement condition.
- A review of the existing profile grade line should be conducted and areas of significant deviation investigated through analysis of core samples in the laboratory.

Repairs-Bonded Resurfacing of Asphalt or Composite Pavement

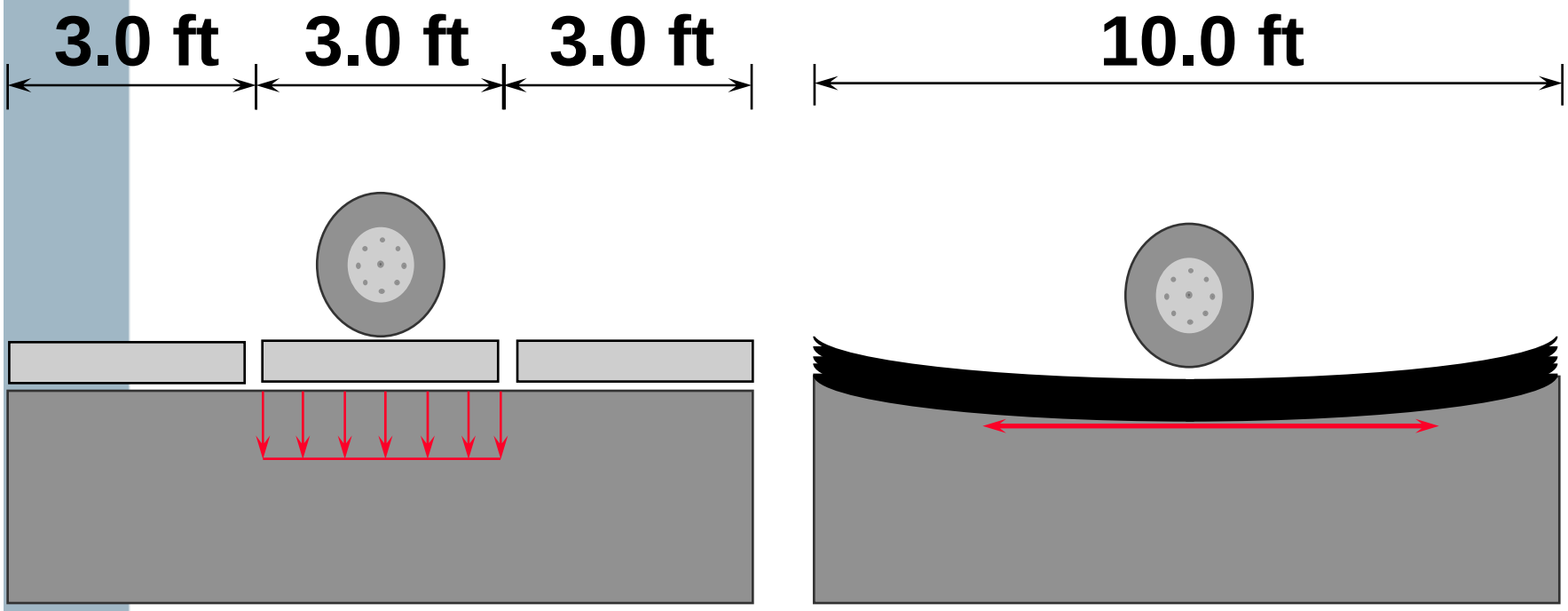




Existing pavement distress	Spot repairs to consider
Fatigue cracking	Full-depth repair patch
Pothole	Full-depth repair patch
Deep rutting	Milling
Shoving, slippage	Milling
Thermal cracking	None

Effects of Joint Spacing:

Bonded Concrete Resurfacing of Asphalt Pavements



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

Milling: Bonded Resurfacing of Asphalt or Composite Pavements

The three main objectives of milling:

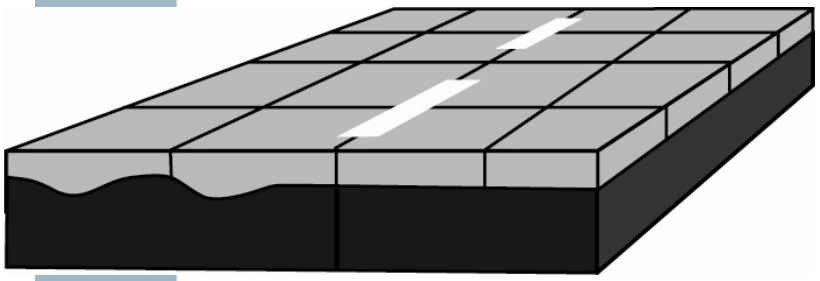
1. to remove significant surface distortions that contain soft asphalt material, resulting in an inadequate bonding surface
2. to reduce high spots to help ensure minimum resurfacing depth and reduce the quantity of concrete needed to fill low spots; and
3. to roughen a portion of the surface to enhance bond development between the new concrete overlay and the existing asphalt. (don’t leave a thin lift)

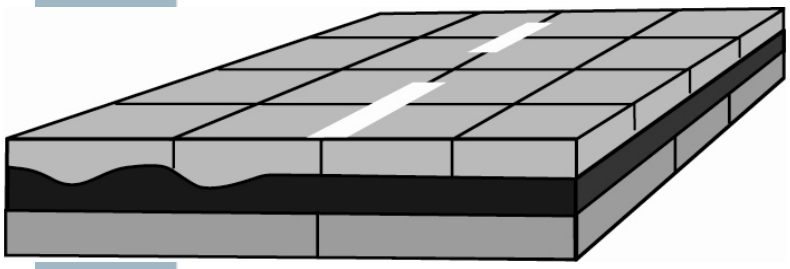
Milling: Bonded Resurfacing of Asphalt or Composite Pavements

- Complete removal of ruts is not needed when rutting in the existing asphalt pavement does not exceed 2”.
- Any ruts in the existing pavement are filled with concrete, resulting in a thicker concrete overlay above the ruts.

- A minimum of 3"–4" of asphalt should be left after milling because of the reliance on the asphalt pavement to carry a portion of the load.

Important Elements-Bonded Resurfacing of Asphalt/Composite Pavement



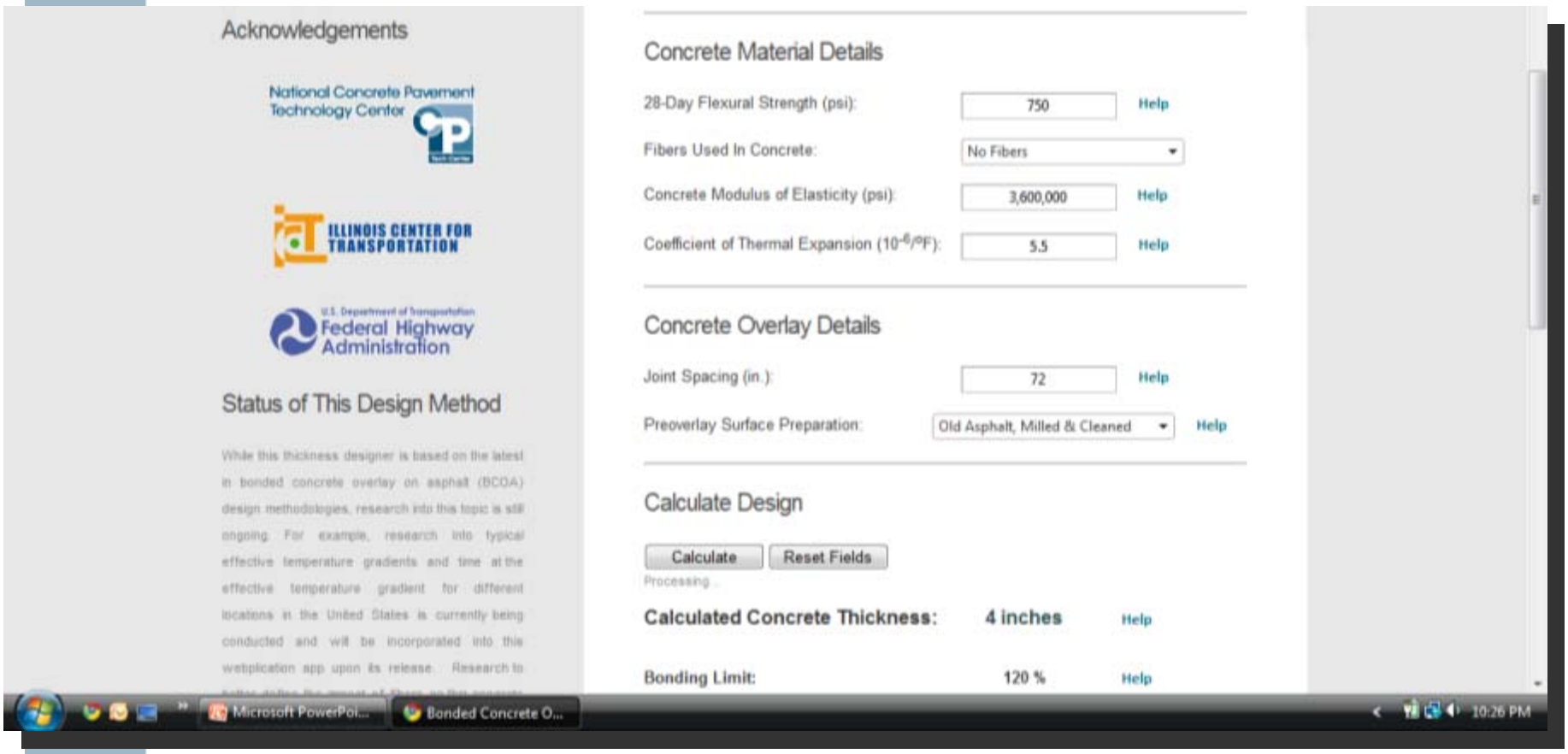


- Clean Surface/Bond is important for good performance
- Thin milling may be required to eliminate significant surface distortions of 2” or more and provide good bond.
- Leave at least 3” remaining asphalt after milling.

- Control surface temperature of existing asphalt to below 120ºF.
- Try to keep joints out of wheel paths.
- Curing should be timely and adequate.
- Small joint spacing to minimize bonding shear stress

BCOA Thickness Designer

BCOA Thickness Designer



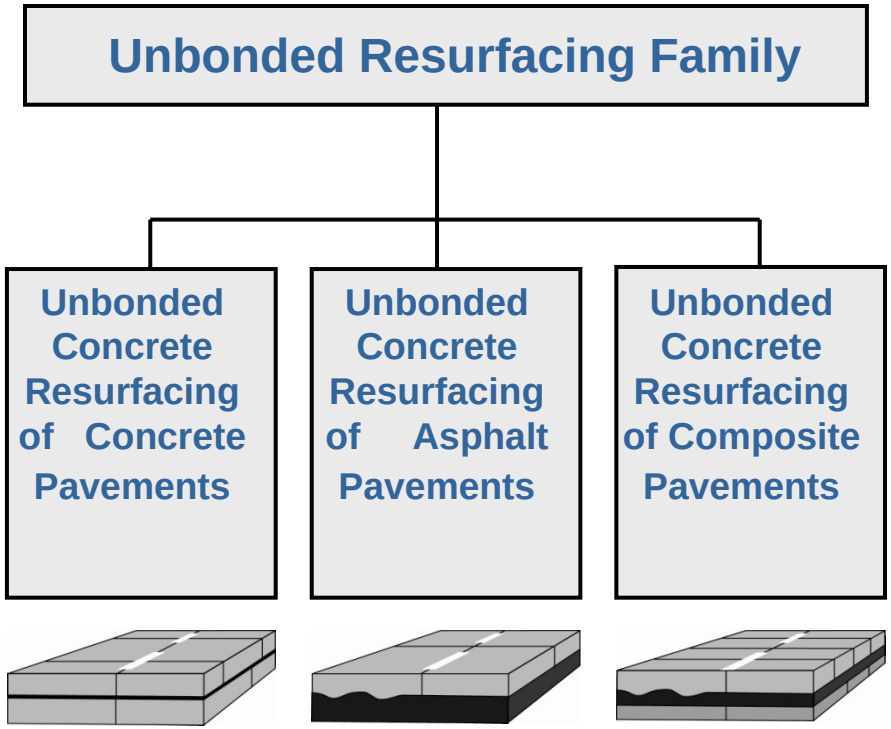
View @ http://apps.acpa.org/apps/bcoa.aspx

BCOA Thickness Designer

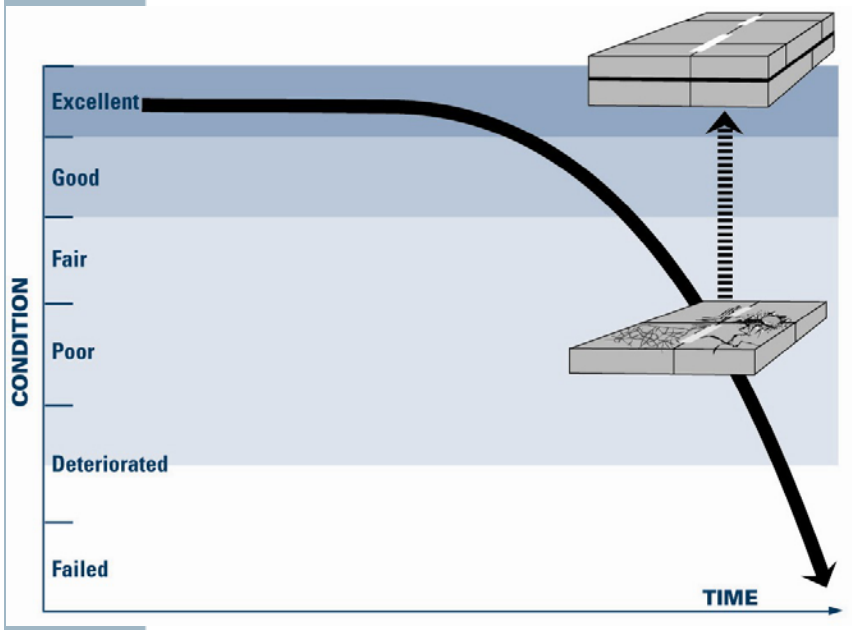
- Available 24-7 from web
- Calibrated with available overlay performance data (Illinois, Iowa)
- Research underway to improve some criteria (by CP Tech Center)
  - Temperature modeling
  - Calibration
- Will incorporate technology into ACPA's StreetPave along with other design models

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 Resurfacing of Concrete Pavements



4” - 11” thickness

- Use when existing pavement is in poor condition, including with material-related distress such as D-cracking and ASR, when underlying pavement and subbase are 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.
- Also results in improved surface friction, noise, and ride.

Unbonded on Concrete

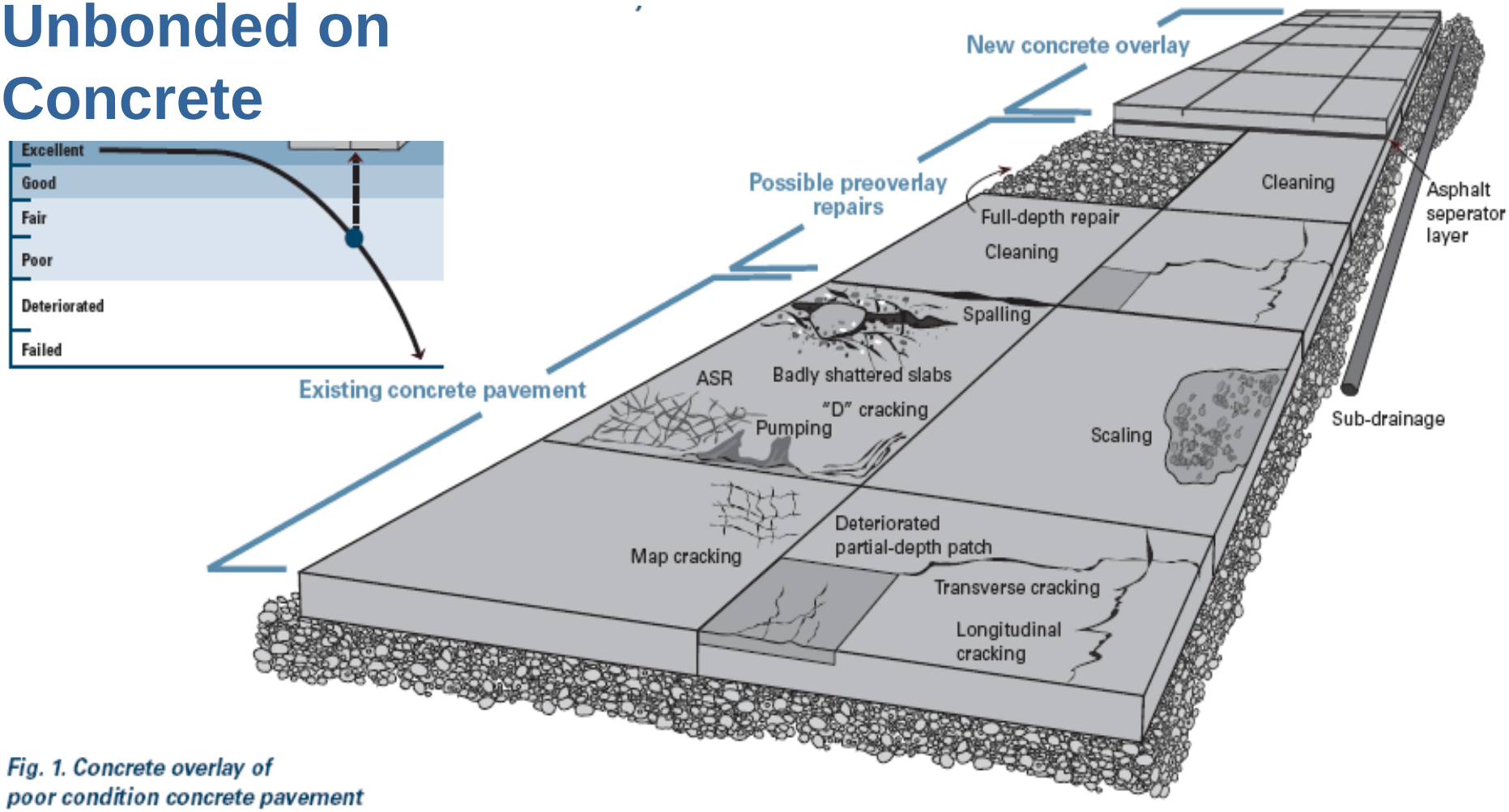


Fig. 1. Concrete overlay of poor condition concrete pavement

- The evaluation establishes whether the existing concrete and its subbbase 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.

Unbonded on Concrete

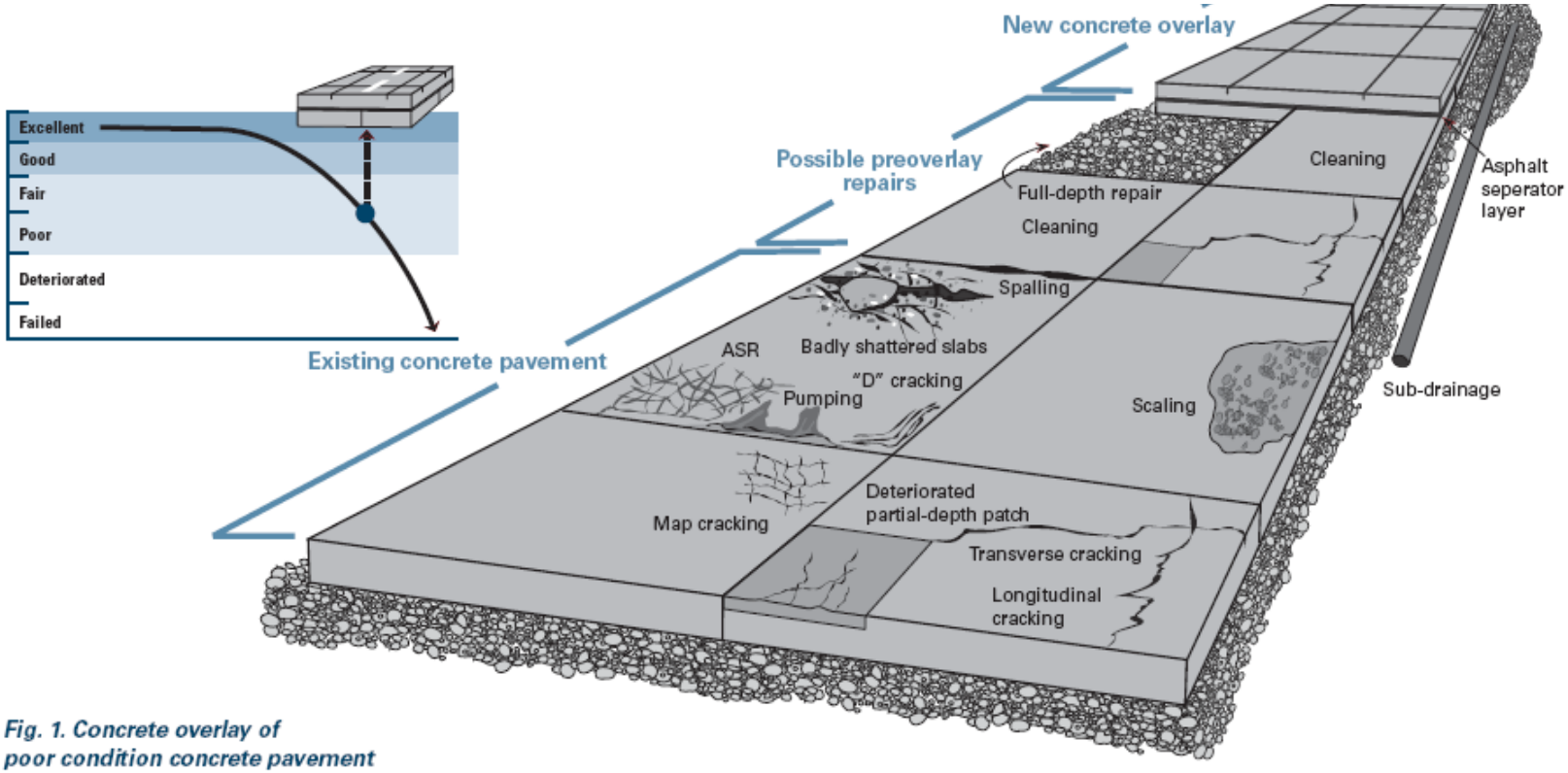
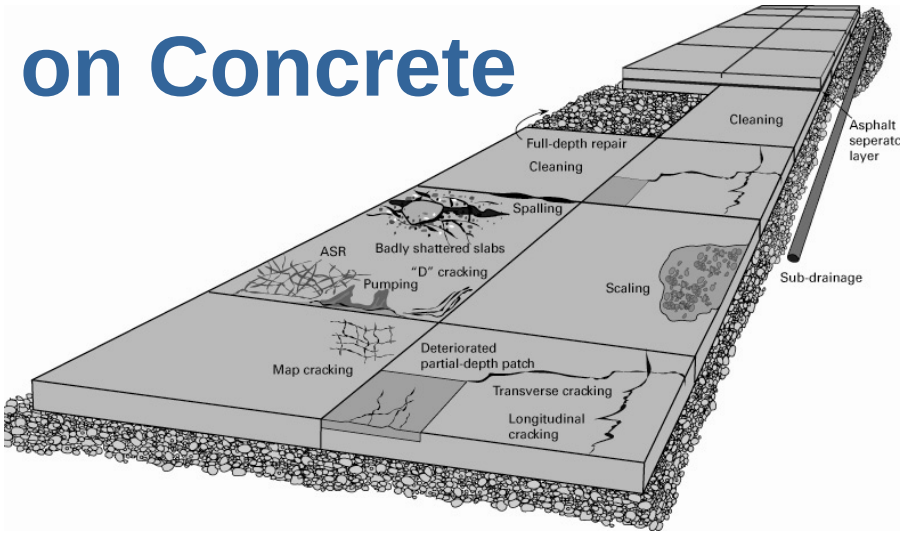


Fig. 1. Concrete overlay of poor condition concrete pavement

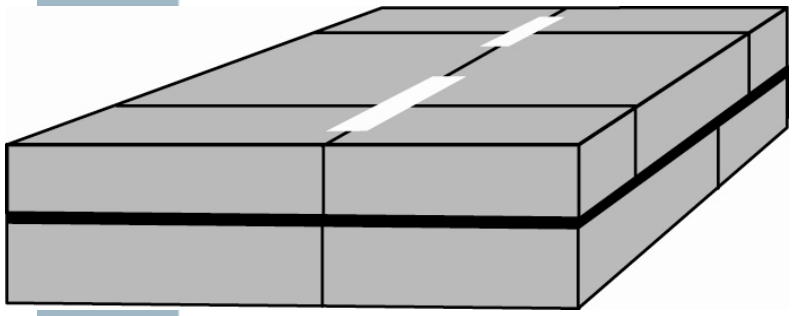
- If the movement is confined to isolated areas, full depth repairs can solve the problem.
- For faulted pavements, if the subgrade is stable, the overlay has proven to be adequate.
- Minor faulting is generally not a concern when a separator layer of 1” or greater is used.

Repairs Unbonded on 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 Resurfacing of Concrete Pavements



- 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.
- Faulting (<3/8”) is generally not a concern when the asphalt separation layer is 1”.
- Shorter joint spacing helps minimize curling and warping stresses.
- No need to match joints with those of the underlying concrete pavement.

Separation for Unbonded Overlays

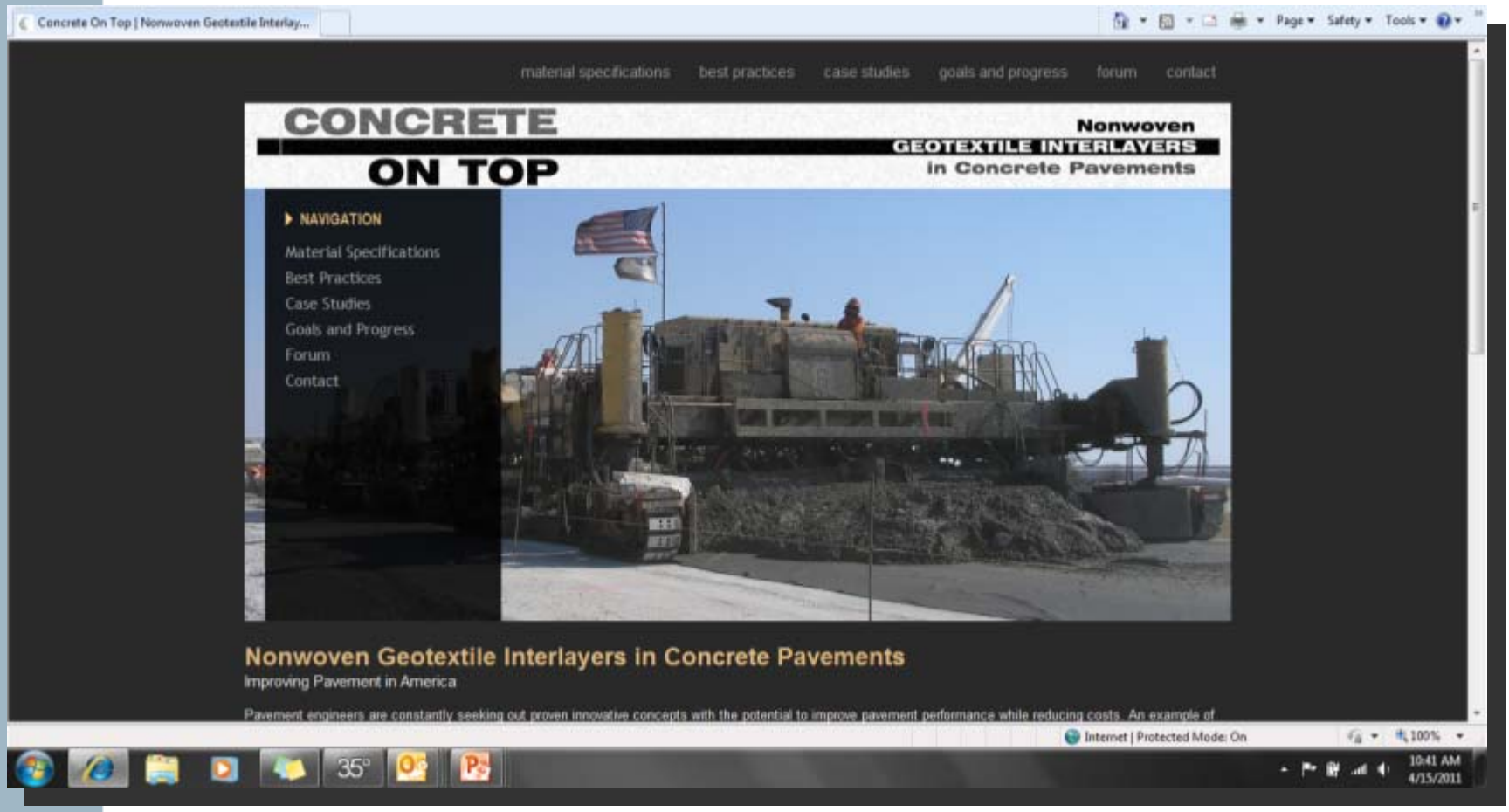
- Separation required for good performance.
  - Isolate overlay from existing pavement:
    - Prevent reflection cracking.
    - Prevent bonding/mechanical interlocking.
    - Provide level surface for overlay construction.
  - Traditional – 1 in dense HMA
  - New – Nonwoven Geotextile fabric (MO, ND, VA…)

Nonwoven Fabric Interlayer

Nonwoven Fabric Interlayer

Nonwoven Fabric Interlayer

Nonwoven Fabric Interlayer

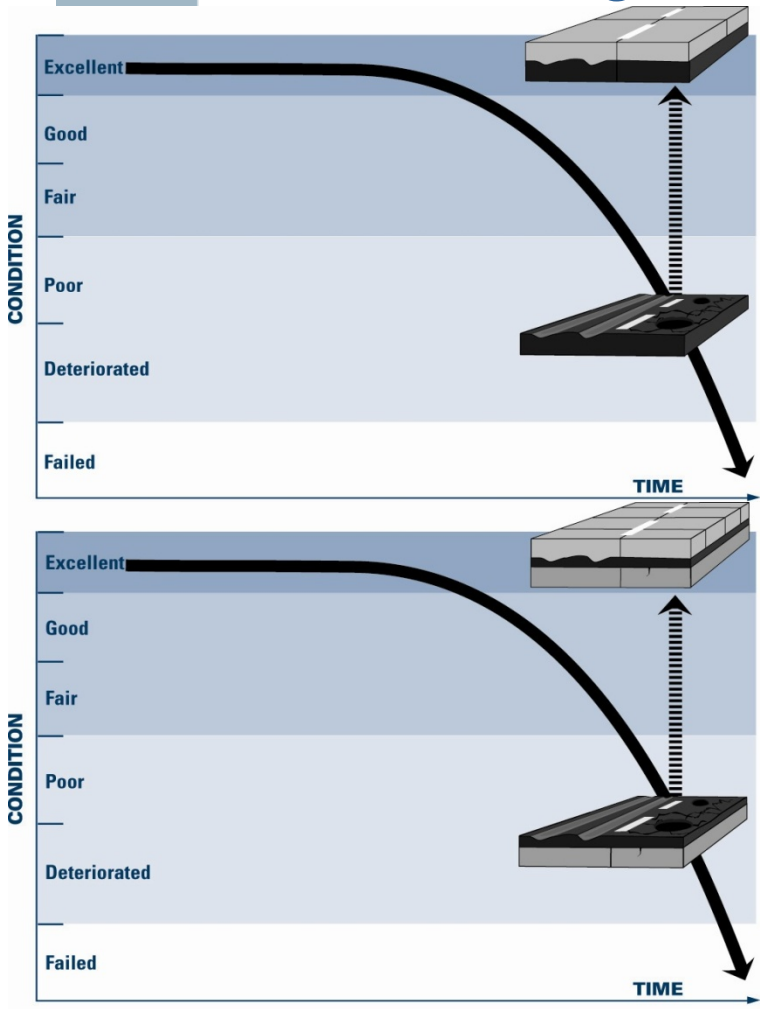


View at: http://www.concreteontop.com/

Benefits of Geotextile Interlayer

- Provides adequate separation
- Avoids another paving operation:
  - Saves on mobilization
  - Avoids materials availability/cost issues
- Reduces overhead clearance issues
- Reduces materials for shoulder fills
- Reduces project costs

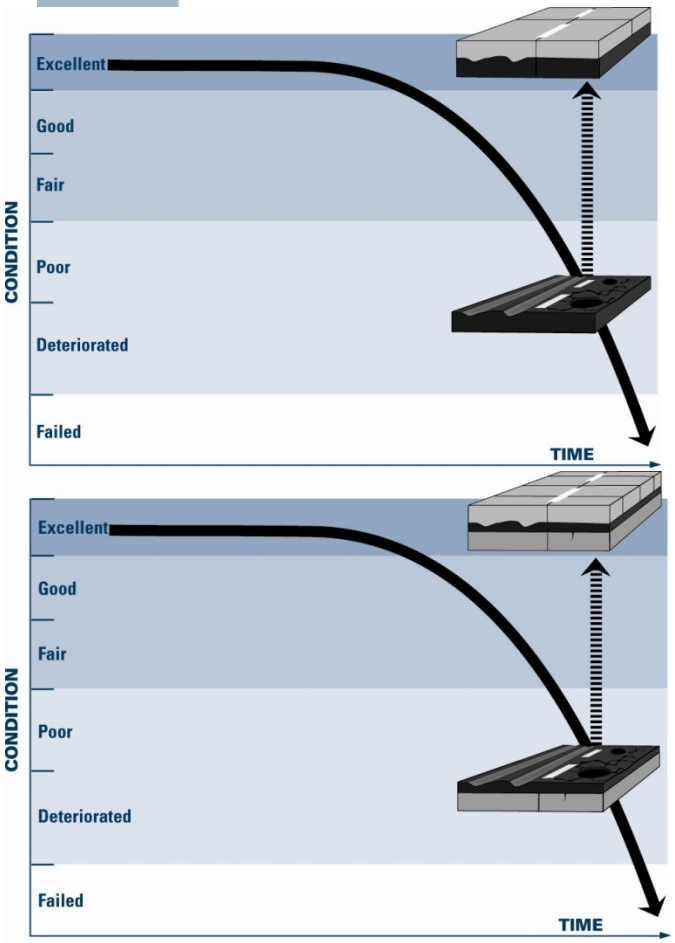
Uses and Advantages - Unbonded Concrete Resurfacing of Asphalt or Composite Pavements



4” - 11” thickness

- Use when existing pavement is deteriorated condition.
  - severe rutting,
  - potholes,
  - alligator cracking,
  - shoving, and pumping
  - exhibits past D-cracking and ASR,
- Used when underlying pavements and subbase are stable and uniform except for isolated areas that can be repaired.

Uses and Advantages - Unbonded Concrete Resurfacing of Asphalt or Composite Pavements

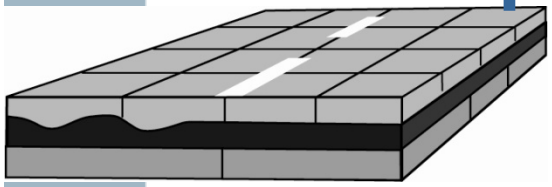


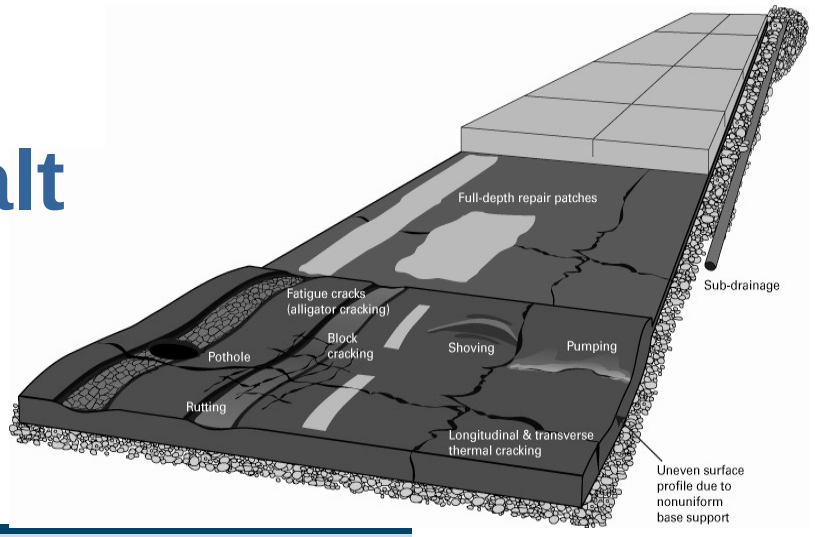
4” - 11” thickness

- Use to restore structural capacity of the existing pavement
- Use to increase pavement life equivalent to full-depth pavement.
- Eliminates rutting and shoving problems and results in improved surface friction, noise, and ride.

Repairs

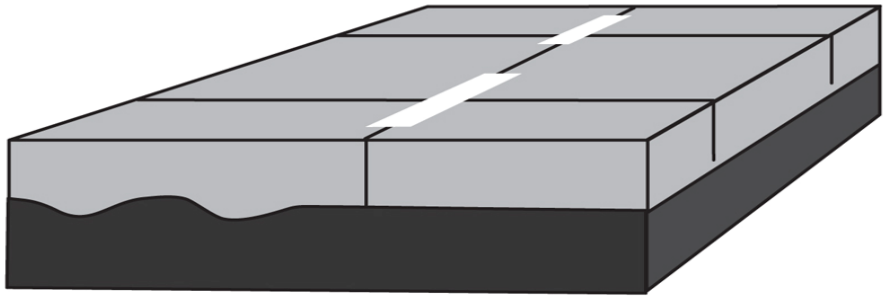
Unbonded on Asphalt or Composite

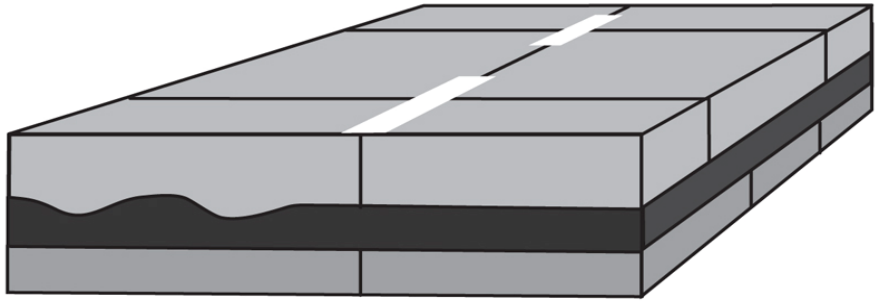




Existing pavement condition	Possible repairs to consider
Area of subgrade failure	Remove and replace with stable material
Severe distress that results in variation in strength of asphalt	Remove and replace with stable material
Potholes	Fill with lean or plain concrete or asphalt
Shoving	Mill
Rutting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

Important Elements - Unbonded Concrete Resurfacing of Asphalt or Composite Pavements





- Full-depth repairs are required only where structural integrity is lost at isolated spots.
- Mill only severe surface distortions.
- Cracks in the asphalt will not reflect up, since concrete overlay movement dominates.
- Timing of the joint sawing is important, particularly for thinner resurfacing.

- Examine profile for distortion at joints.
- Existing asphalt serves as separator layer.
- Slightly shorter Joint spacing than normal

Milling: Unbonded Resurfacing of Asphalt or Composite Pavements

- The amount of asphalt removal depends on the types and severity of distresses and the thickness of the asphalt pavement.
- The objective of removing material is not to obtain a perfect cross section. It is 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 to provide a solid foundation. There is no reason to remove good asphalt which only increase the concrete thickness and project cost

.

Overlay Experiences

- Spokane, WA
  - 3 sections on I-90, 3”, 4”, 5”
  - Constructed in 2004
  - Excellent performance in 4” and 5” sections
  - To be reconstructed this year


EXIT

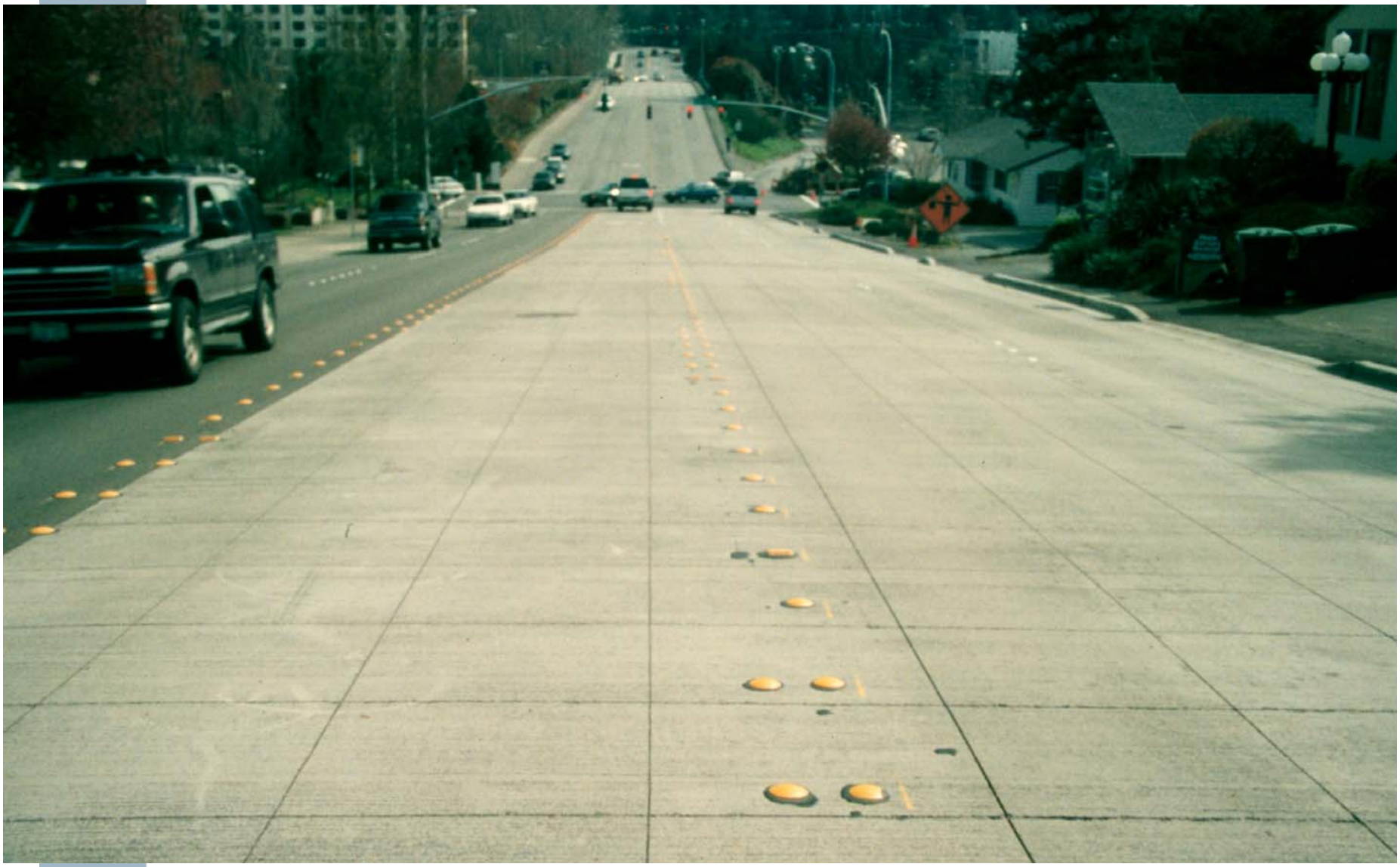
Overlay Experiences

- Kalispell
  - 5” on 3”-5” of HMA
  - 6’ joint spacing
  - 18,000 ADT
  - 30% Trucks
  - Built in 2000
  - Performing very well


A-Core

Overlay Experiences

- Bellevue
  - 3” PCC on 3” AC
  - Built 1998
  - Still in service
  - Cracking in edge panels



Overlay Experiences

- US 20/26 & Middleton Road
- Built in 2005
- 4” on 4”
- Still in service
- Excellent performance


09/08/2010

Overlay Experiences

- NE 92nd, Portland, OR
- 4” fiber reinforced PCC on approx. 3” ACP
- Constructed June 2008
- Still in service
- Excellent performance


SOFF-CUT

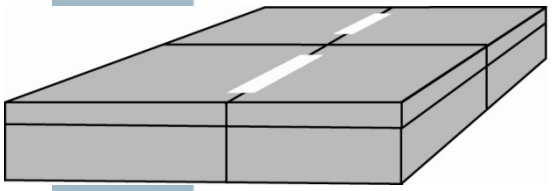
Overlay Experiences

- N Denver Ave, Portland, OR
- 2” fiber reinforced PCCP on approx 2” ACP
- Cracking in panels over utility trench, repaired
- Constructed fall 2010
- Still in service
- Excellent performance


CALPORTLAND
BUMP
N Schofield

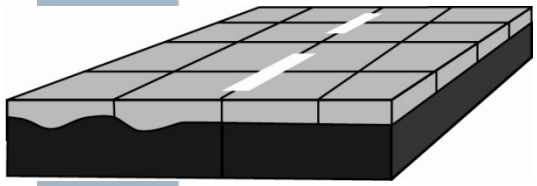
Bonded Resurfacing Family

- **Use to eliminate surface distress (good to fair condition). Concept is for minimal repairs. Bond is essential along with timely of sawing of joints.**



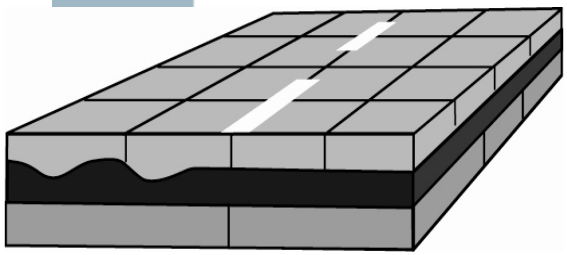
Bonded Concrete Resurfacing of Concrete Pavements
–previously called bonded overlay–

- **Matched joints allow structure to move monolithically.**
- **Concrete with thermal properties similar to that of existing pavement minimizes shear stress in bond.**
- **Cut transverse joints full depth and longitudinal joints T/2.**



Bonded Concrete Resurfacing of Asphalt Pavements
–previously called ultra-thin whitetopping, UTW–

- **Small square panels reduce curling, warping, & shear stresses.**
- **Mill if necessary to correct crown, remove surface distresses, improve bonding. Insure to leave 3” min. HMA after milling.**
- **HMA surface temperature below 120 F before paving.**

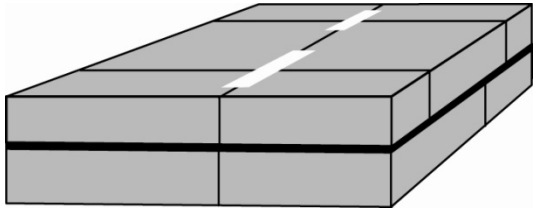


Bonded Concrete Resurfacing of Composite Pavements

- **Same as Asphalt Pavements.**
- **Look at HMA profile and condition for underlining PCC distress.**

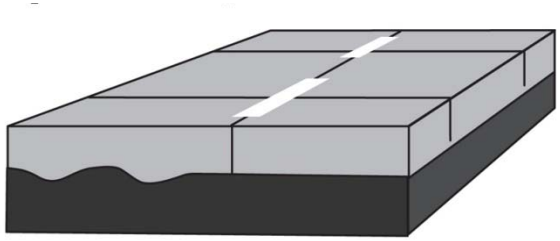
Unbonded Resurfacing Family

- **Use to eliminate surface and structural distress (poor to deteriorated condition). Successfully used with high reliability. Concept is for minimal repairs**



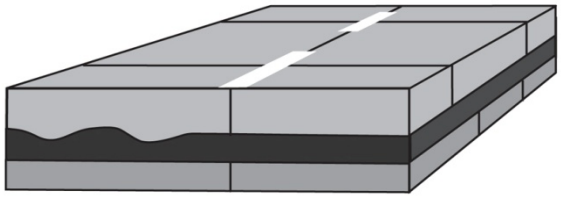
Unbonded Concrete Resurfacing of Concrete Pavements
–previously called unbonded overlay–

- Asphalt separator layer is important to isolate unbonded resurfacing from underlying pavement and minimize reflective cracking.
- Shorter joint spacing helps minimize curling and warping stresses.



Unbonded Concrete Resurfacing of Asphalt Pavements
–previously called conventional whitetopping–

- Unbonded resurfacing movement dominates underlying asphalt.
- Slightly smaller than normal joint spacing is common and depends on the thickness of the underlying pavement and the unbonded resurfacing.



Unbonded Concrete Resurfacing of Composite Pavements

- Existing asphalt serves as separator layer.
- Slightly smaller than normal joint spacing is common and depends on the thickness of the underlying pavement and the unbonded resurfacing.

THANK YOU !

Jim Powell

American Concrete Pavement Association

Northwest Chapter

jim@nwpavement.com

(360) 956-7080