



# Bonded Concrete Overlays Over Asphalt (BCOA)

TERRA Web Meeting

March 24, 2015

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# THE CP Tech Center

The National Concrete Pavement Technology Center (National CP Tech Center) at Iowa State University is a national hub for concrete pavement research and **TECHNOLOGY TRANSFER**.

## **MISSION:**

- Help street and road agencies find answers to their concrete pavement-related questions.
- Identify critical concrete pavement research needs and discover sustainable solutions.
- **Help agencies, industry, and businesses incorporate advanced, sustainable solutions and new technologies into their day-to-day practices.**

# Concrete Overlay Tech Support

- Tasked by FHWA to support state and local agencies with implementation of concrete overlays
- Involved in 30+ states since 2008
- Tech support for project scoping, PS&E and through construction

**We do not promote or sell concrete overlays, our job is to provide unbiased technical support to agencies**

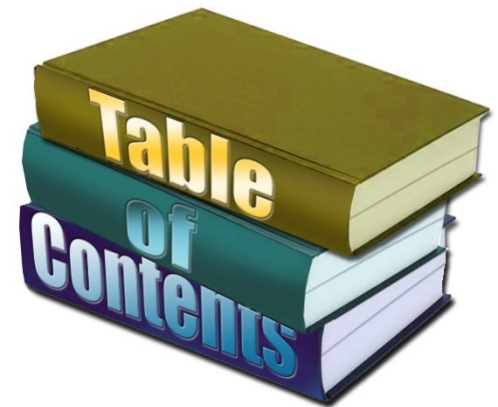
# Objectives of Today's Discussion

- Answer the following
  - Why consider bonded concrete on asphalt (BCOA) overlays?
  - Will it be durable?
  - How long will it take to construct?
  - What are the important elements to meet the design objectives?



# Outline of Today's Discussion

1. Introduction to concrete overlays and Performance of BCOA
2. Evaluation & selection of BCOA candidates
3. Material consideration
4. BCOA design (thickness & design details)
5. Maintenance of traffic for overlays and BCOA construction
6. Q and A

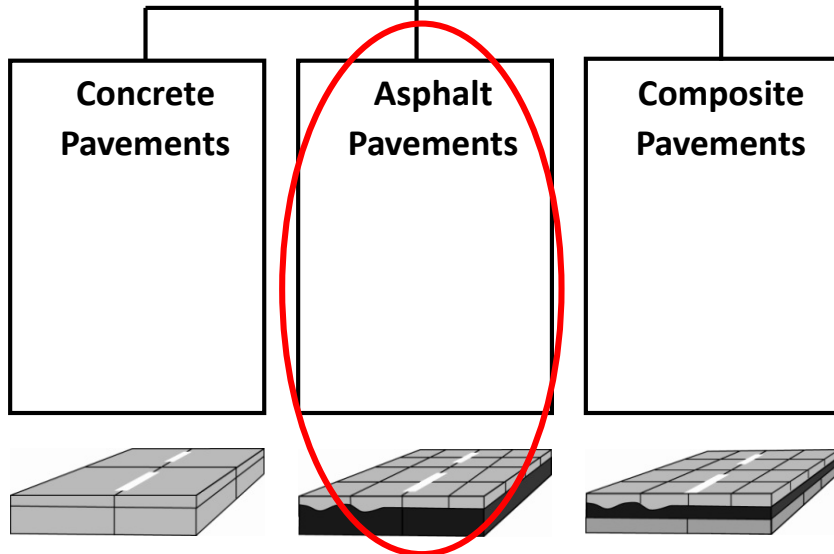


# Concrete Overlay Introduction and BCOA Performance

# System of Concrete Overlays

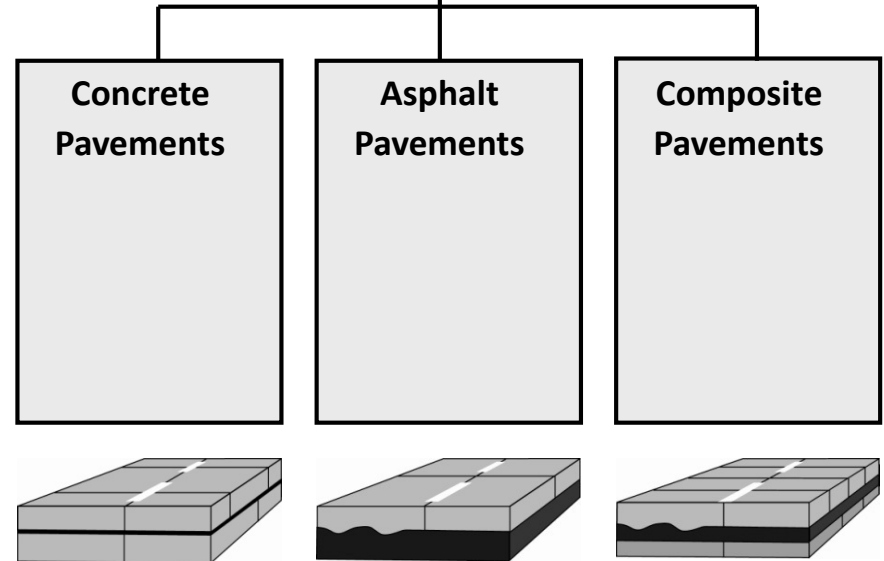
## Concrete Overlays

### Bonded Overlay System



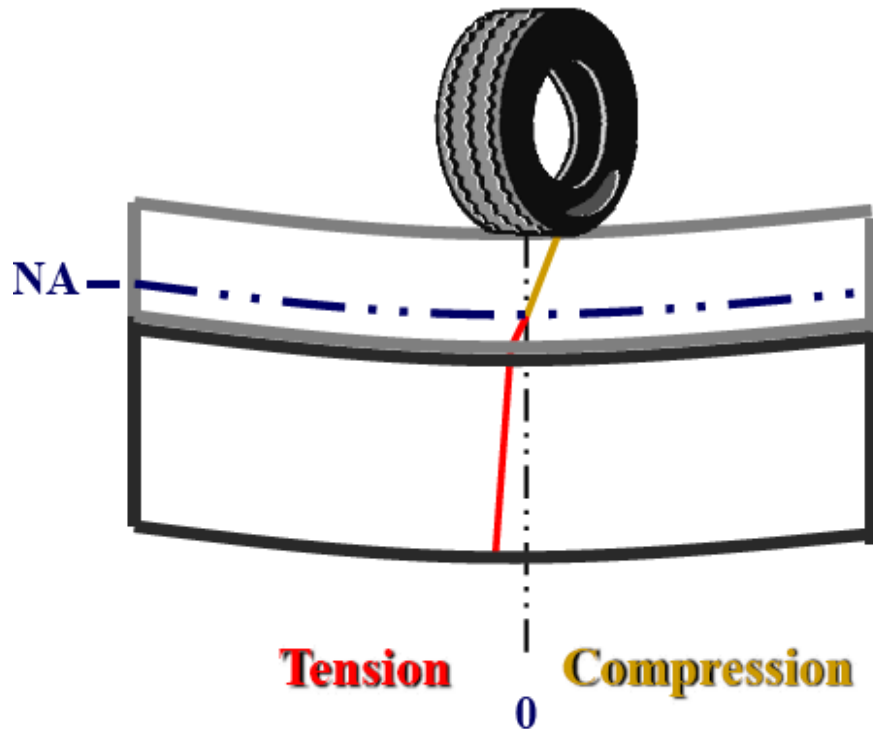
Bond is integral to design

### Unbonded Overlay System

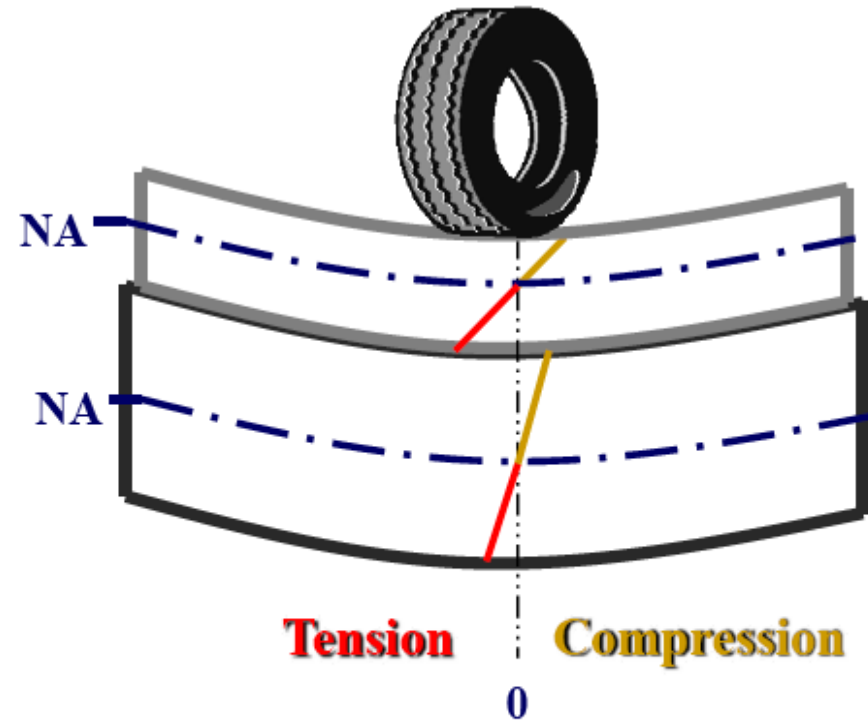


Old pavement is subbase

# Bonded and Unbonded



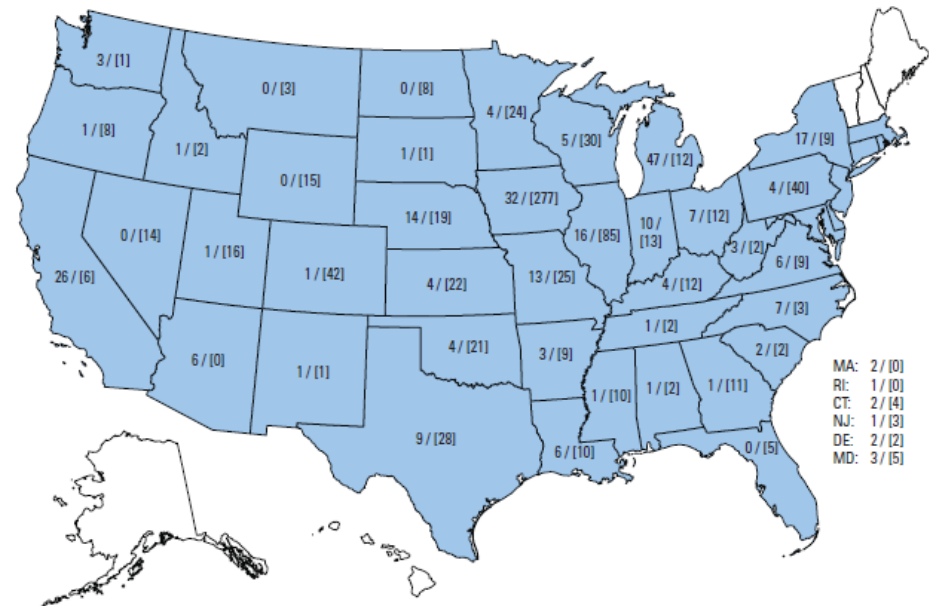
**Bonded**



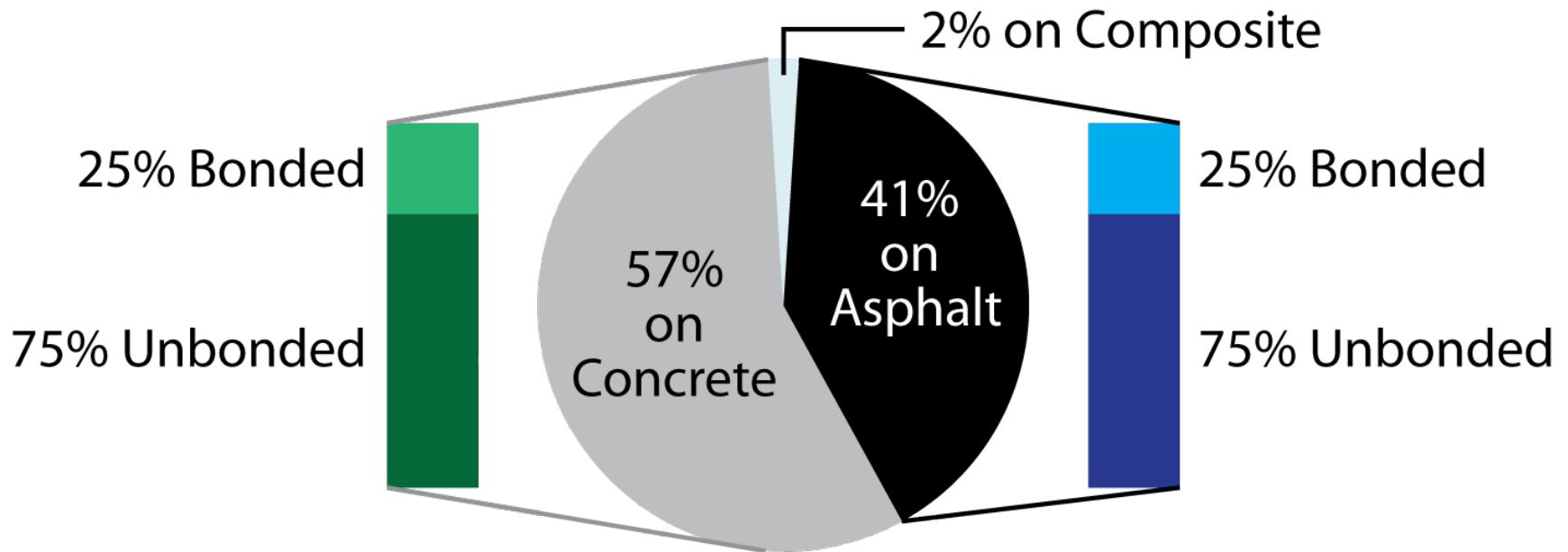
**Unbonded**

# Concrete Overlays - Introduction

- 1,152 concrete overlays in the U.S., dating from to **1901** through 2012 (the database is continuing to grow)
- Concrete overlays have been successfully constructed in 45 different states



# Bonded vs. Unbonded



(by number of projects)

*Based on over 1,000 concrete overlays from NCHRP Synthesis 99, NCHRP Synthesis 204, and **ACPA's National Overlay Explorer***

# Case History #1

## US-69 Oklahoma

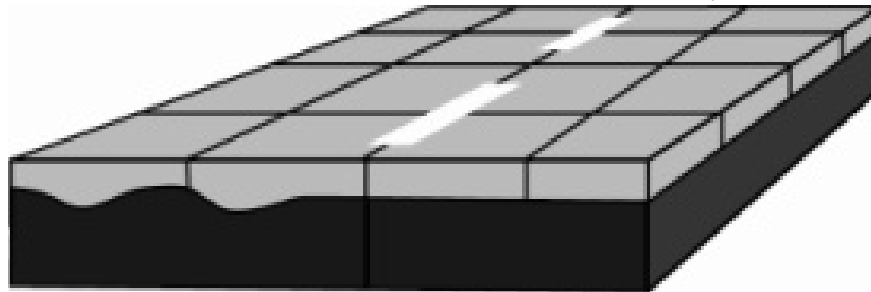


# Case History #1

## US-69 Oklahoma

- Bonded on Asphalt

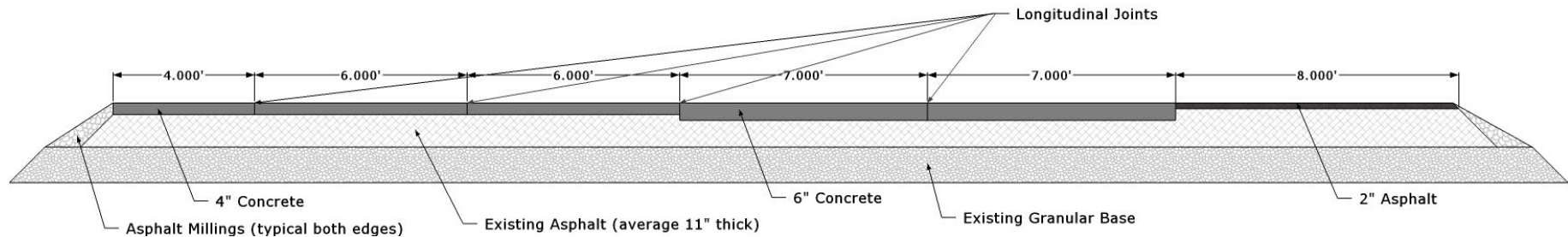
- **4" and 6" thickness**
- **13 years old**
- **10,100,000 ESALs**



# Case History #1

## US-69 Oklahoma

- Typical Section
  - 4" and 6" concrete pavement
    - Slab sizes (w x l): 4' x 6', 6' x 6' and 7' x 6'
  - Existing asphalt pavement milled (approx. 11" remaining)
  - Existing granular base



# Case History #1

## US-69 Oklahoma

- Constructed adjacent to traffic
- Fiber reinforced (3 lb/yd<sup>3</sup>)



# Case History #1

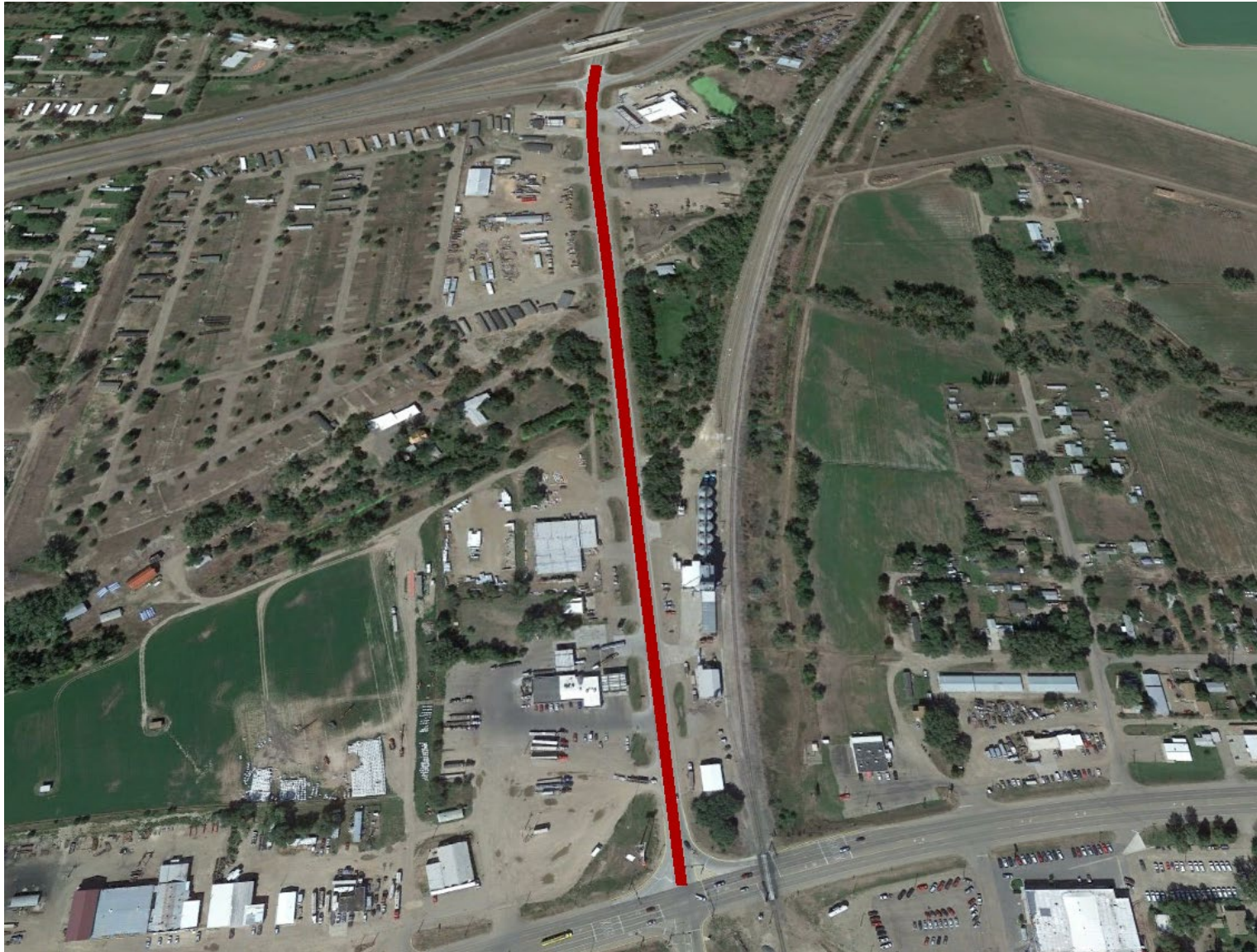
## US-69 Oklahoma

- Less than 1% cracked slabs after 9 years



# Case History #2

## SR-16 Montana

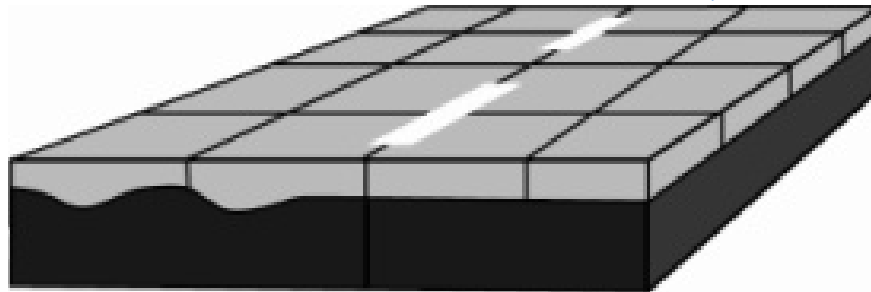


# Case History #2

## SR-16 Montana

- Bonded on Asphalt

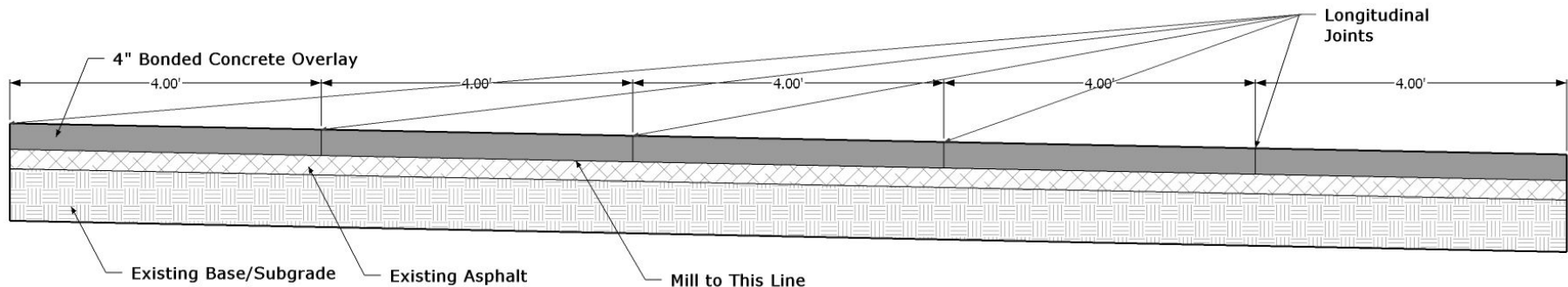
- **4" thick**
- **13 years old**
- **2,200,000 ESALs**



# Case History #2

## SR-16 Montana

- Typical Section
  - 4" concrete pavement
    - Slab sizes (w x l): 4' x 4'
  - Existing asphalt pavement milled
  - Existing base/subgrade



# Case History #2

## SR-16 Montana

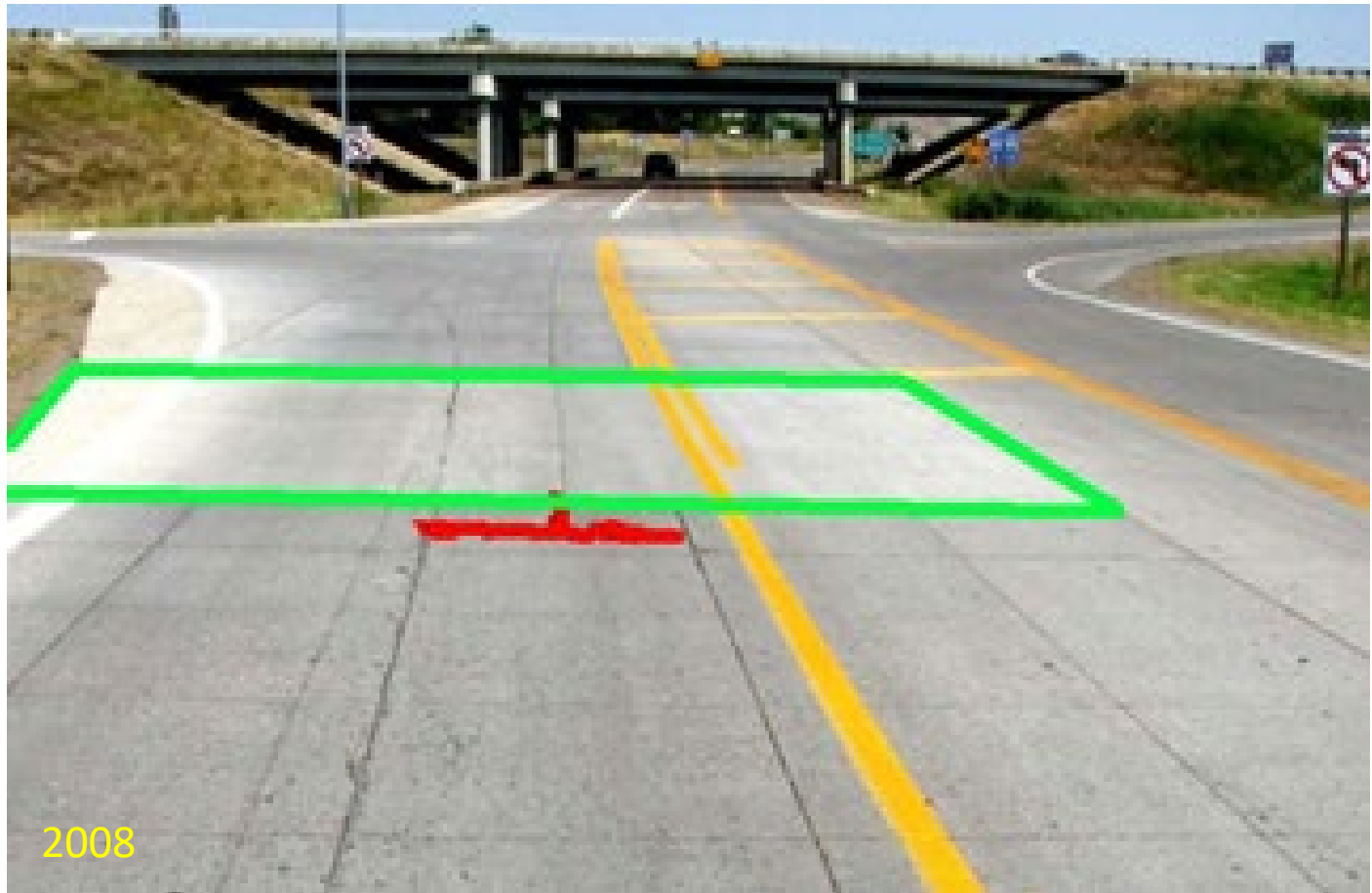
- Traffic maintained during construction
- Fiber reinforced (3 lb/yd<sup>3</sup>)



# Case History #2

## SR-16 Montana

- Full depth replacement of 15 slabs (0.2%) in 2005



# BCOA Pavement Evaluation

# General Feasibility—Bonded PCC Overlays

- **Bonded Concrete of HMA & Composite**
  - “Good” to “fair” HMA pavements with:
    - Limited structural (fatigue) cracking
    - No stripping/raveling in HMA layers
    - HMA thick > 3-5 inches (after milling)

# Concrete Overlays

## Service Life Expectations

- Thickness of 2 to 6 in. – 15 to 25 years
- Thickness > 6 in. – 20 to 30+ years

Overlay service life is dependent upon :

- Sound overlay structural design - compatible with expected traffic and site conditions, and
- Good construction practices

# 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
2. Coring Pavement
3. Field Tests Where Necessary
4. Condition Assessment Profile

# Evaluation of Existing Pavement

- Concrete overlays require uniform support conditions and movement control.
- The evaluation of the existing pavement is paramount to determine if uniform support and movement control exists, or if it can be cost-effectively achieved.
- Premature overlay failure can be traced to some violation “picking the wrong project” to overlay or designing/constructing it incorrectly.

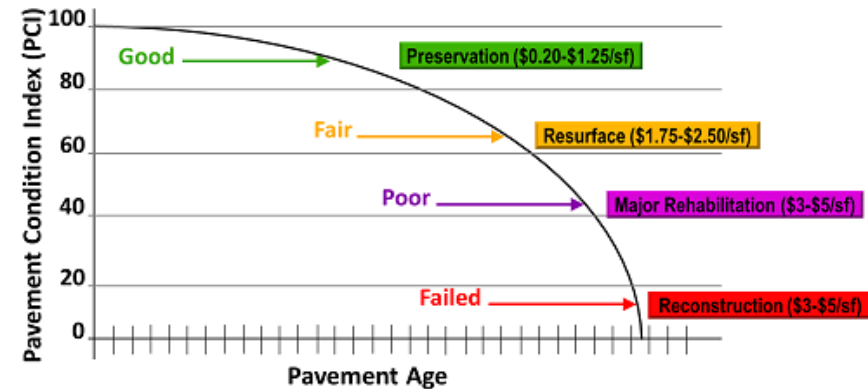
# Evaluations of Existing Pavements

- Evaluation is also used to determine:
  - Required repairs where needed
  - Establish the concrete overlay design thickness
  - 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)



# 1. Pavement History

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



Concrete

Asphalt / Composite

## 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



# 3. Coring

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



# Is the Existing Pavement a Good Overlay Candidate?

- Overall pavement condition
- Understand the pavement thickness options
- Subgrade / subbase condition
- Understanding the existing pavement materials
- Climatic conditions
- Drainage conditions
- Existing grades and cross slopes



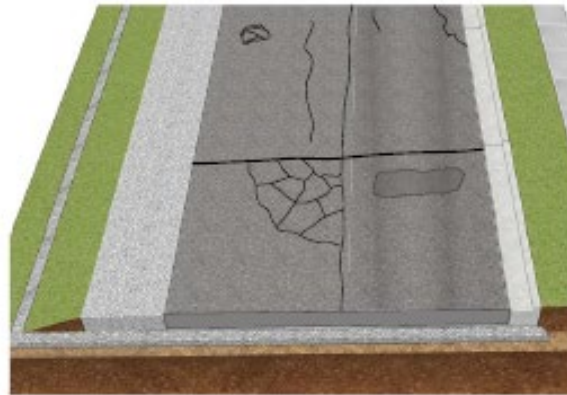
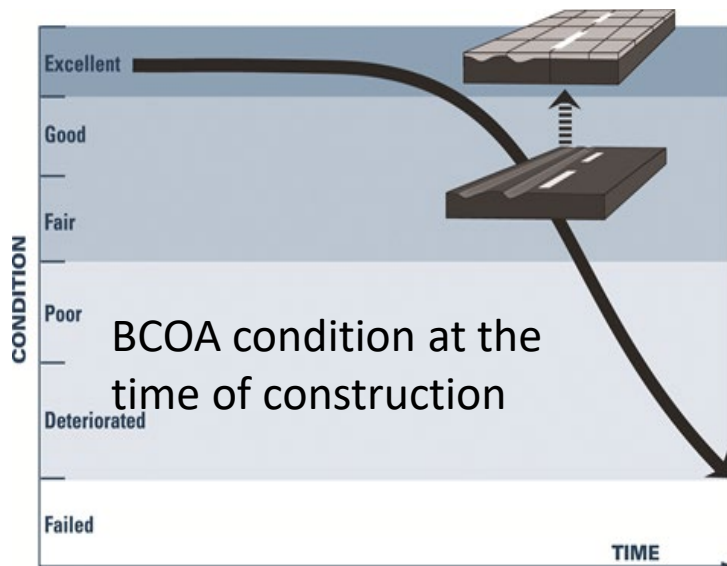
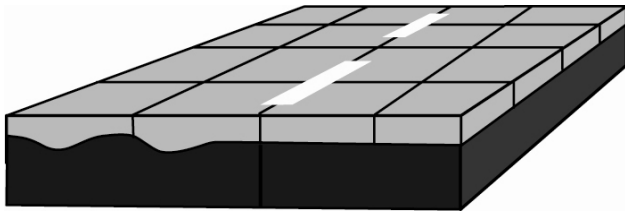
# Is the Existing Pavement a Good Overlay Candidate?

- Geometric factors
- Vertical restrictions
  - Bridges
  - Curb/gutter
  - Cross streets
- Utilities/fixed structures
- Shoulders/ditches
- Traffic control constraints



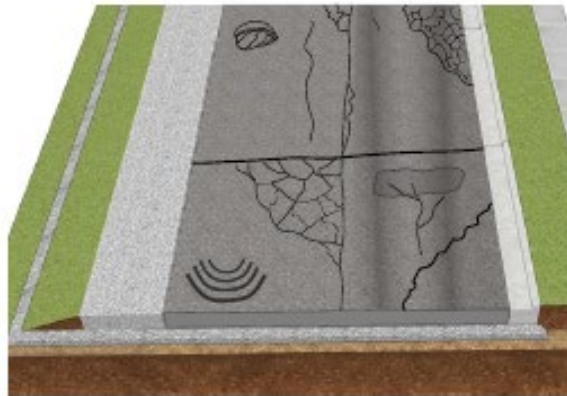
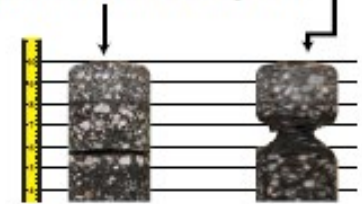
# Overlay Selection

## – Existing Asphalt



### Fair Condition

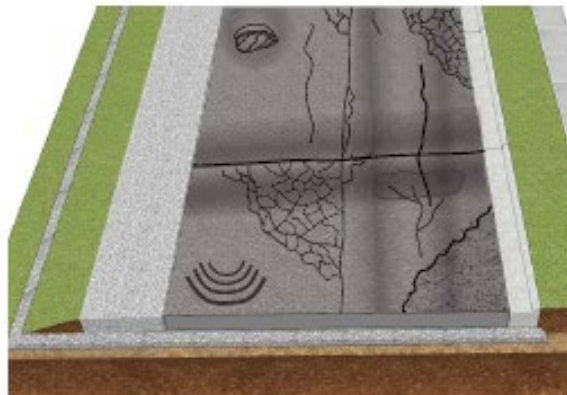
Structurally sound but has minor surface distresses such as potholes, block cracking, random thermal cracking. Check for undulating profile grade to determine if sub drainage issues exist. Check cores to ensure no measureable stripping or delamination in the asphalt.



### Poor Condition

Has measurable distresses beyond those described as Fair conditions such as alligator cracking, rutting, shoving, slippage, stripping, raveling and freeze-thaw damage.

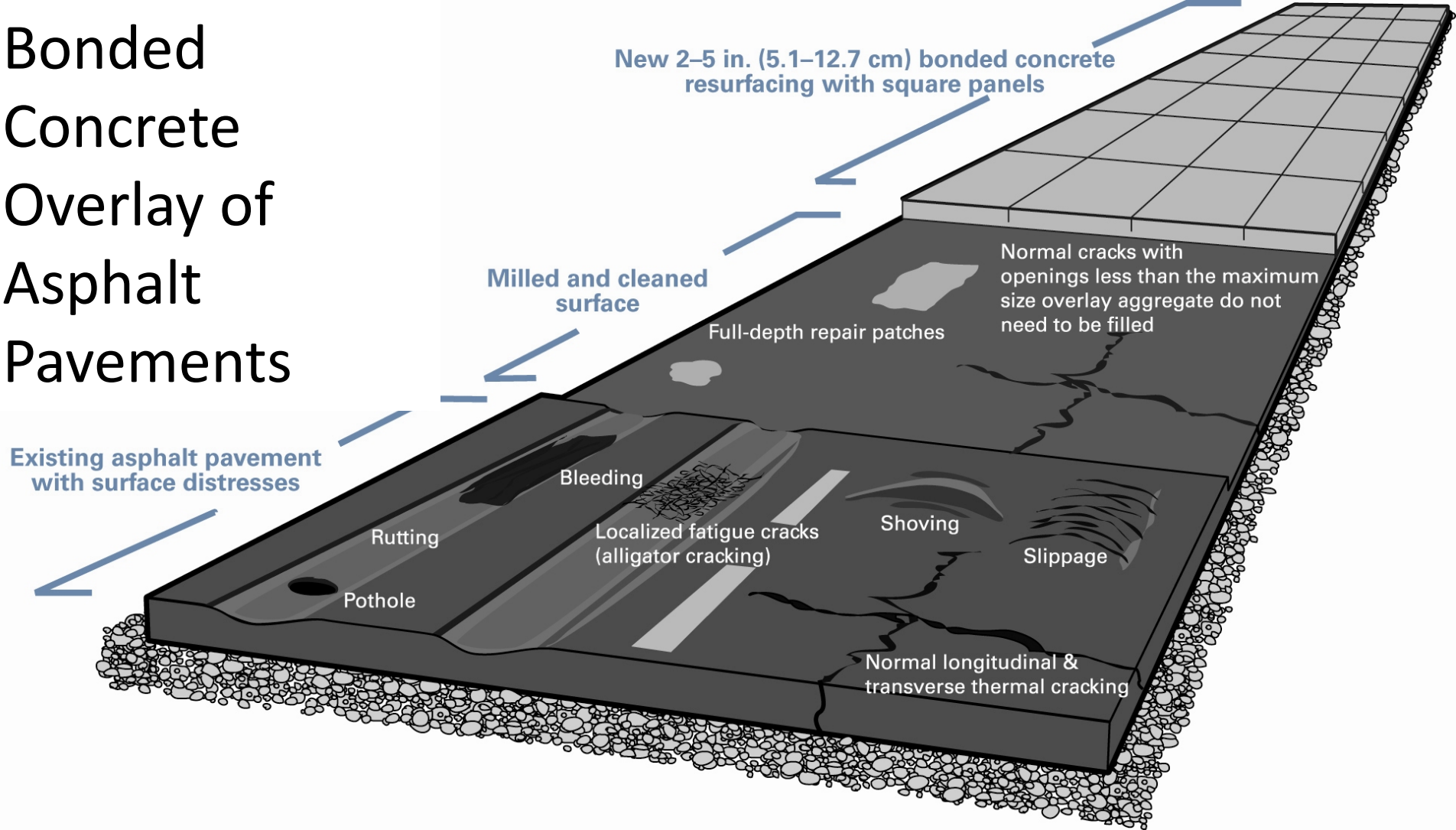
Note: Asphalt is a good reflector of underlining distresses such as a poor subbase conditions.



### Deteriorated Condition

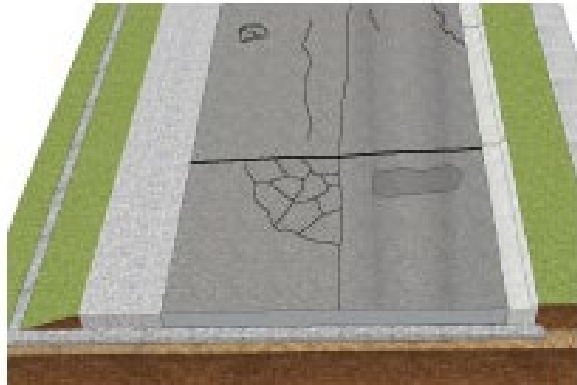
Exhibits Poor Conditions as well as significant deterioration, raveling, thermal expansion, stripping and structural distresses.

# Bonded Concrete Overlay 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 strengthened through patching. Milling can remove a number of asphalt surface distresses.

# 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

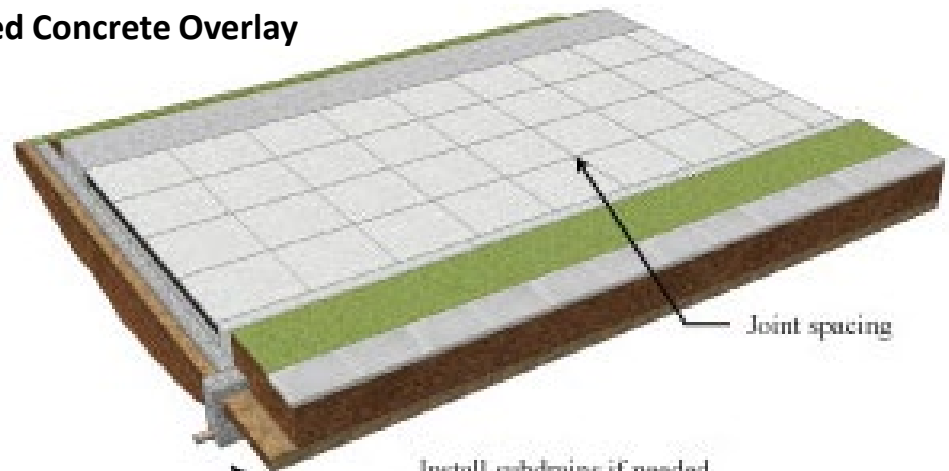
Can milling and minor spot repairs cost effectively solve deficiencies, bring the pavement to “Good Condition” and meet other constraints (i.e., vertical clearance, shoulders, safety rails, foreslopes, etc.) to allow for bonded overlay?

NO

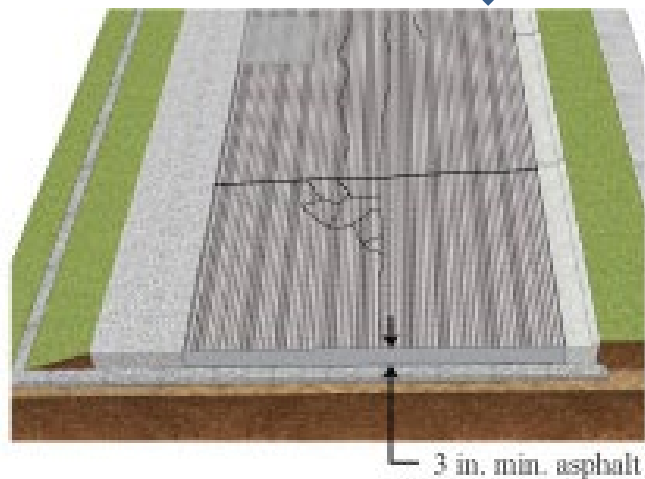
Yes



## Bonded Concrete Overlay

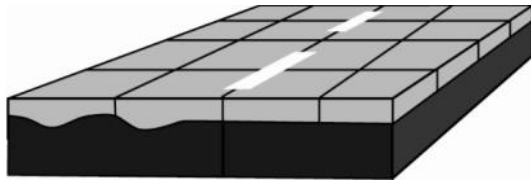


Note: Concrete overlay thickness must be appropriately designed considering estimated traffic, desired design life, and budget



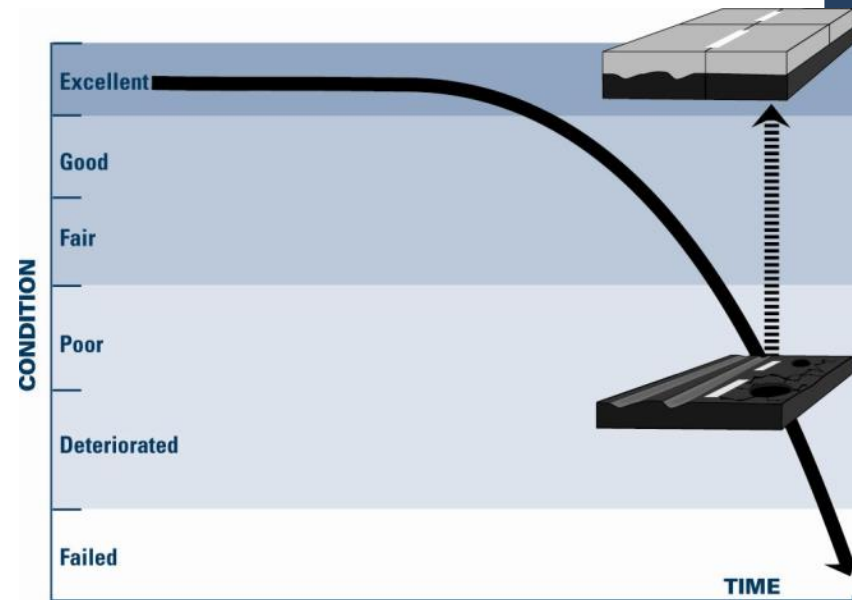
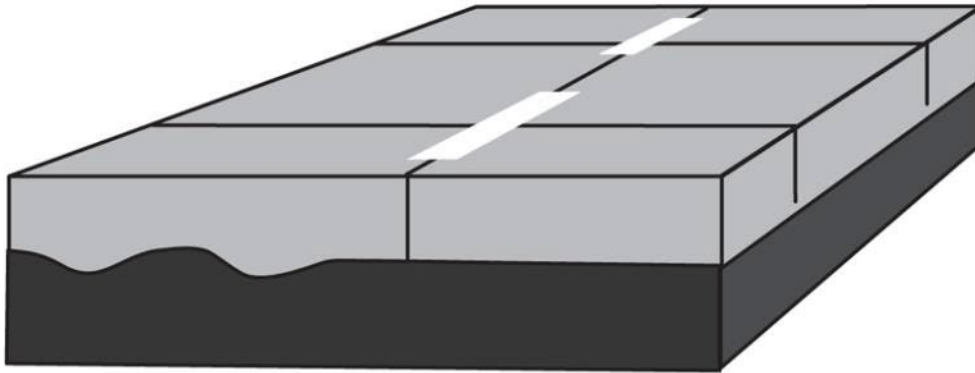
# Bonded Over Asphalt/Composite

## 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.
- Be sure to leave 3" to 4" 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

# When Bonded is not a Good Candidate an Unbonded Overlay Should be Considered



# Material Considerations

# Understanding Asphalt Pavement for BCOA

Elements in Design and Construction which needs addition before Concrete Overlay

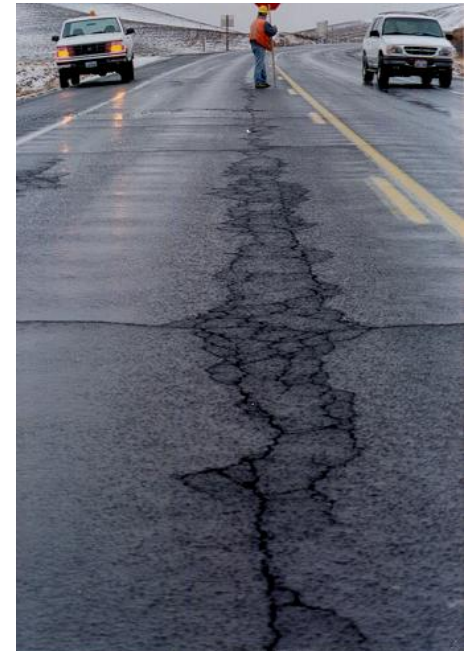
- Stripping
- Thermal, working, alligator and block cracking

# Stripping

The loss of bond between aggregates and asphalt binder that typically begins at the bottom of the HMA layer and results in structural support

## Summary of Possible Causes:

- Water in the HMA causing asphalt binder stripping along the aggregate face
- Bottom-up stripping is difficult to recognize because it manifests itself on the pavement surface as other forms of distress including rutting, shoving/corrugations, raveling, or cracking.
- Asphalt overlays over existing open-graded surface course can result in stripping.



# Asphalt Stripping Leading to Fatigue Failure



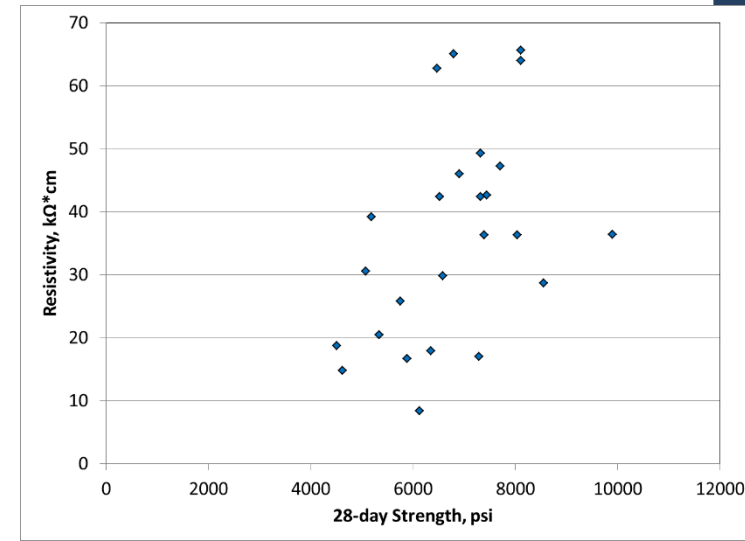
# Concrete Mix should be an Emphasis on Durability

- What do I want?
- What is in it and so what?
- How do I get what I want with what I have?
- How do I know?



# Common Misconceptions

- More cement means stronger concrete
- Supplementary cementitious materials are dilutants
- Stronger concrete is more brittle & that is bad
- Strength and workability are correlated
- Strength and durability are correlated



# Optimized Gradation

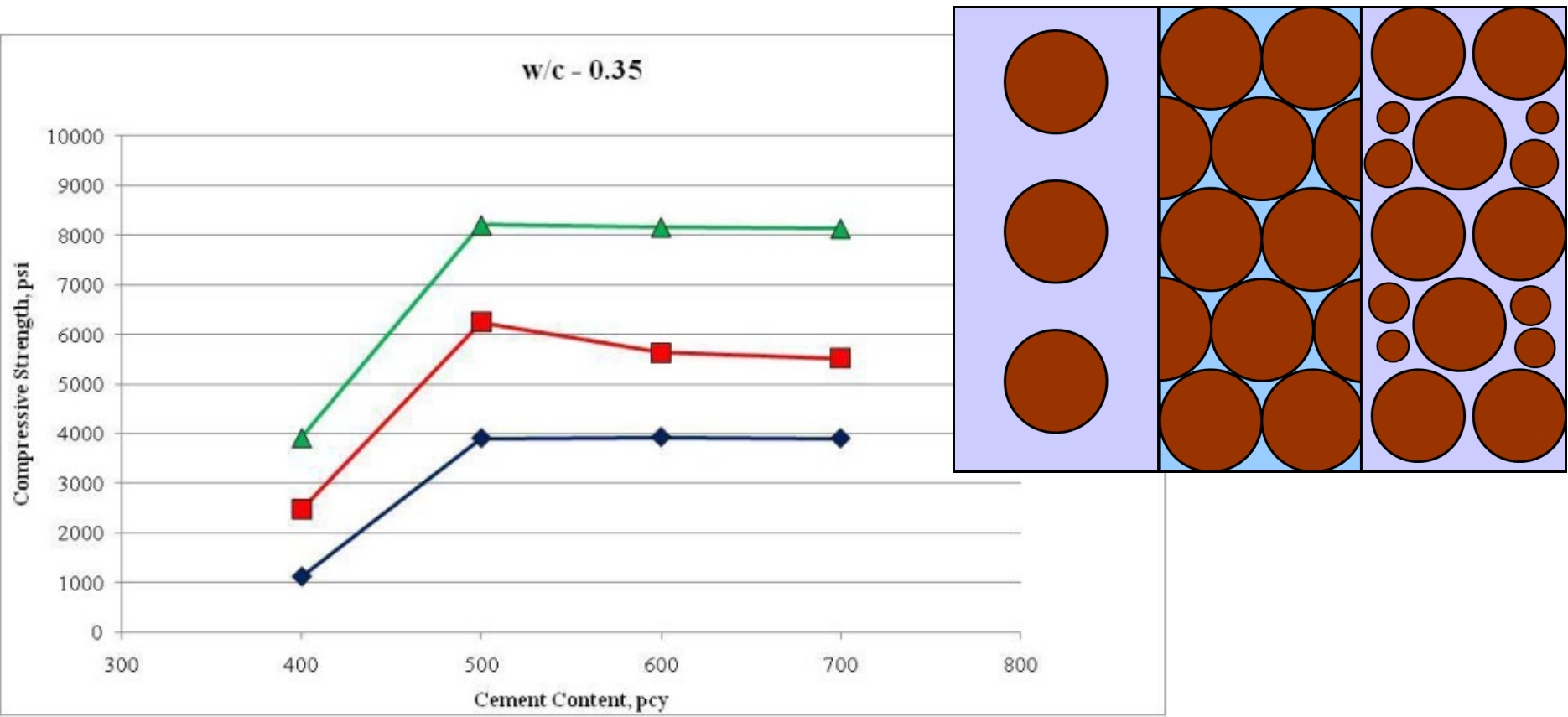
- Improved workability for a given water content (W/CM)
  - Portland cement = 293 lb/yd<sup>3</sup>
  - Type C fly ash = 158 lb/yd<sup>3</sup> (35% replacement)
  - W/CM = 0.42 (22.7 gal/yd<sup>3</sup>)
  - Mid-Range WRA
  - **OPTIMIZED GRADATION**



# Paste Volume

## Choose Paste Volume

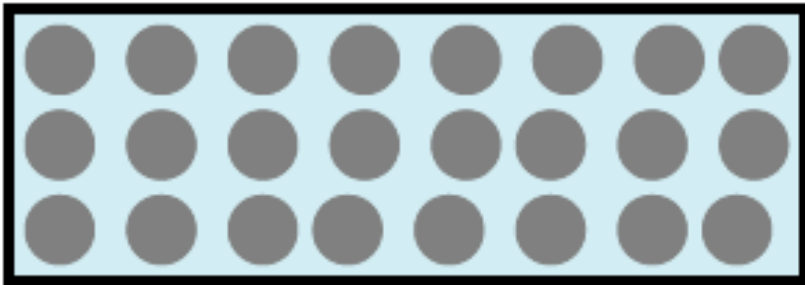
- All voids must be filled with paste
- And a bit more to coat the particles for workability



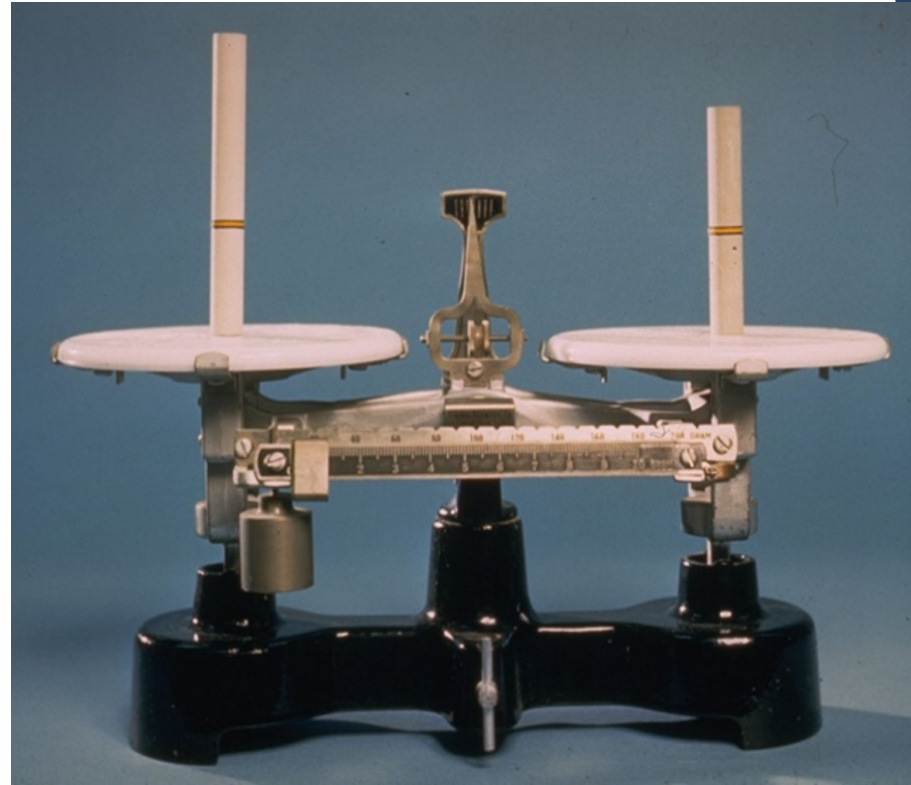
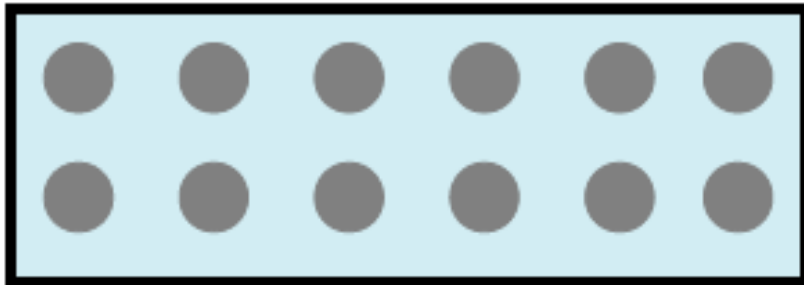
# Permeability

- More water – means more space between cement grains.  
Two cylinders weigh the same but one is much denser than the other; therefore be stronger and less permeable

$w/c = \text{Low}$



$w/c = \text{High}$



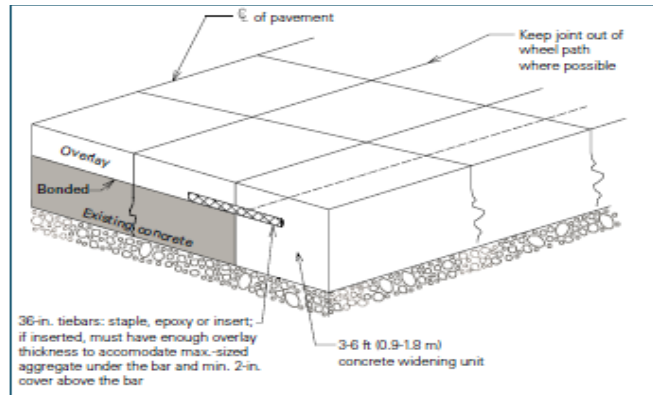
# Air Entraining Admixtures

- Provide resistance to freezing and thawing
- Improved workability, reduced water, and reduced segregation
- ASTM C 260
- Specify air content  $6.5\% \pm 1.5\%$



# Tie Bars Typically Used in Overlays When

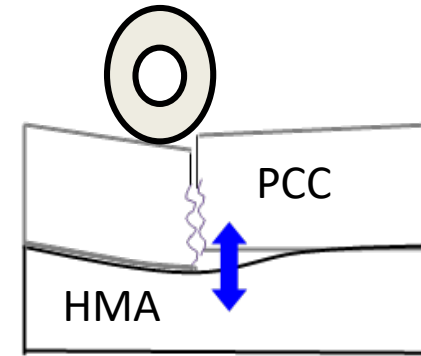
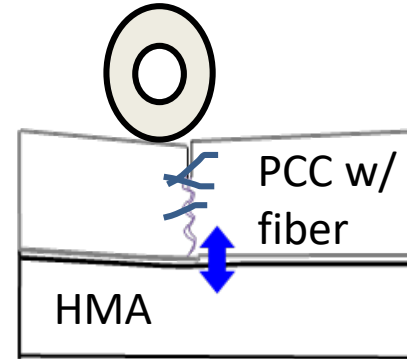
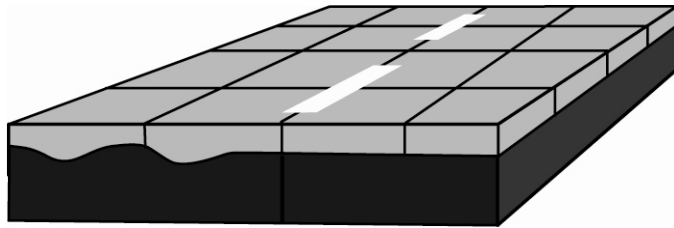
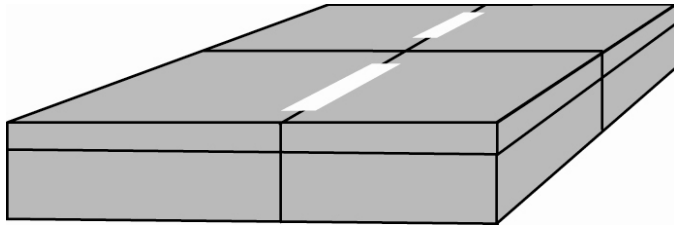
- Thickness  $\geq 5''$
- New curb and gutter- thickness  $\geq 6''$
- Lane widening or paved shoulders



- Reinforce cracks

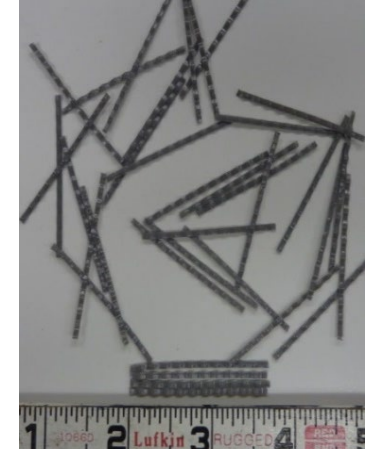


# Structural Fibers Bonded Overlays



Straight synthetic:  
Strux 90/40

Residual  
strength ratio =  
24%



Crimped synthetic:  
Enduro 600

# Fiber-Reinforced Concrete

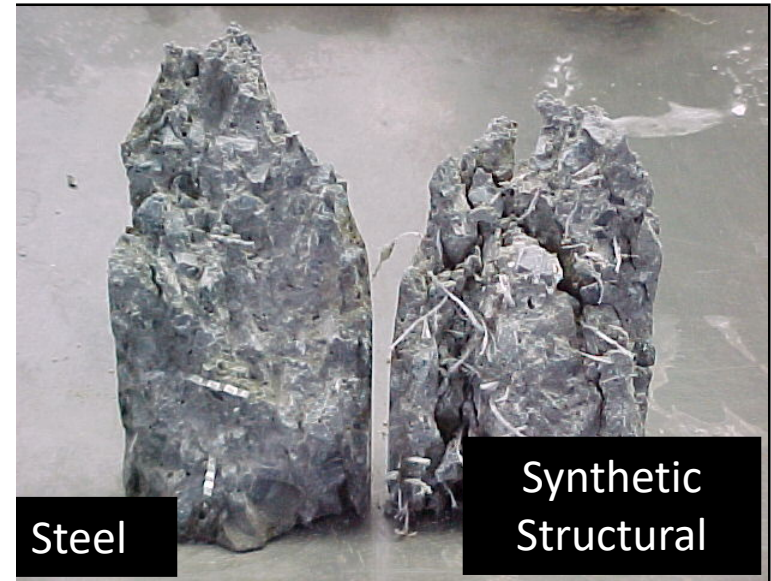
- However, fiber reinforcement should be considered in any of the following situations:
  - The project has specific vertical restrictions
  - The asphalt lift is very thin (and thus may not readily bond with the concrete)
  - The base thickness and/or condition is inadequate
  - The design thickness makes conventional reinforcement difficult to use
  - The design life needs to be increased
  - An increase in heavy-truck traffic is planned or anticipated



# Structural Fibers Considerations

- No increase in concrete's strength, but in fatigue capacity
- Increases toughness
- Increases post-crack integrity
  - Helps control plastic shrinkage cracking
- Macro Synthetic most common (0.26% by volume ).
- \$0.70/sq yd for 4lb dosage per cu.yd
- 3 to 5 min. mixing with 2"±

Slump loss



# Curing of Overlays

- Cure as soon as practical
- Even and complete coverage
- Consistent operating speed
- Edge covered also
- Even and complete cover
- Adjust for dry and/or wind
- Clean/adjust nozzles
- Keep it wet, keep it warm: for durability



# BCOA Overlay Design

# Important Considerations in Overlay Design

- Required Future Design Life of the Overlay
- Traffic Loading (ESALs)
- Traffic Distribution
- Existing Asphalt Conditions-Reflective Crack
- Pre-overlay Repair
- Subdrainage
- Shoulders
- Vertical restrictions

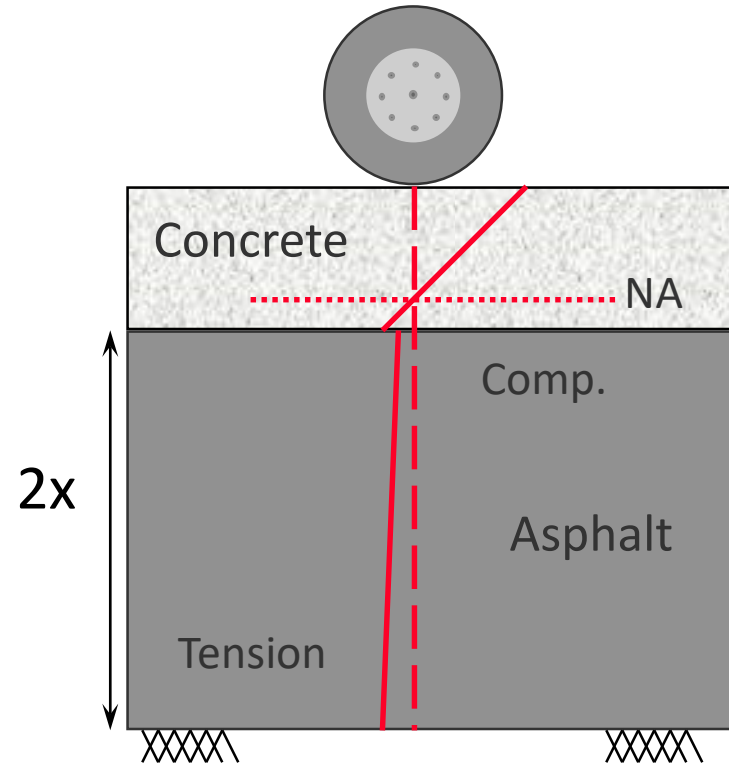
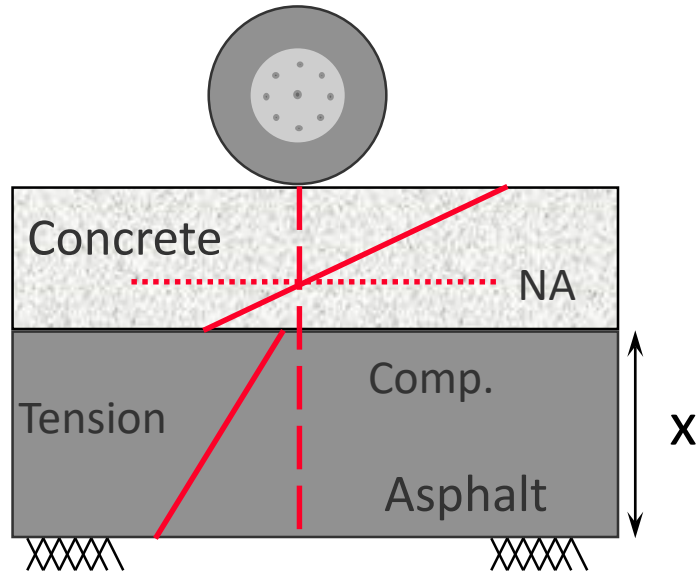


# How Do Bonded Overlays over Asphalt Work?

- Concrete bonds to the asphalt
  - Lowers the neutral axis
  - Decreases stresses in the concrete
- Short joint spacing
  - Controls cracking
  - Slabs act as paver-blocks
- Fibers improve concrete toughness



# Effects of AC Thickness



# Bonded Concrete Overlay Thickness

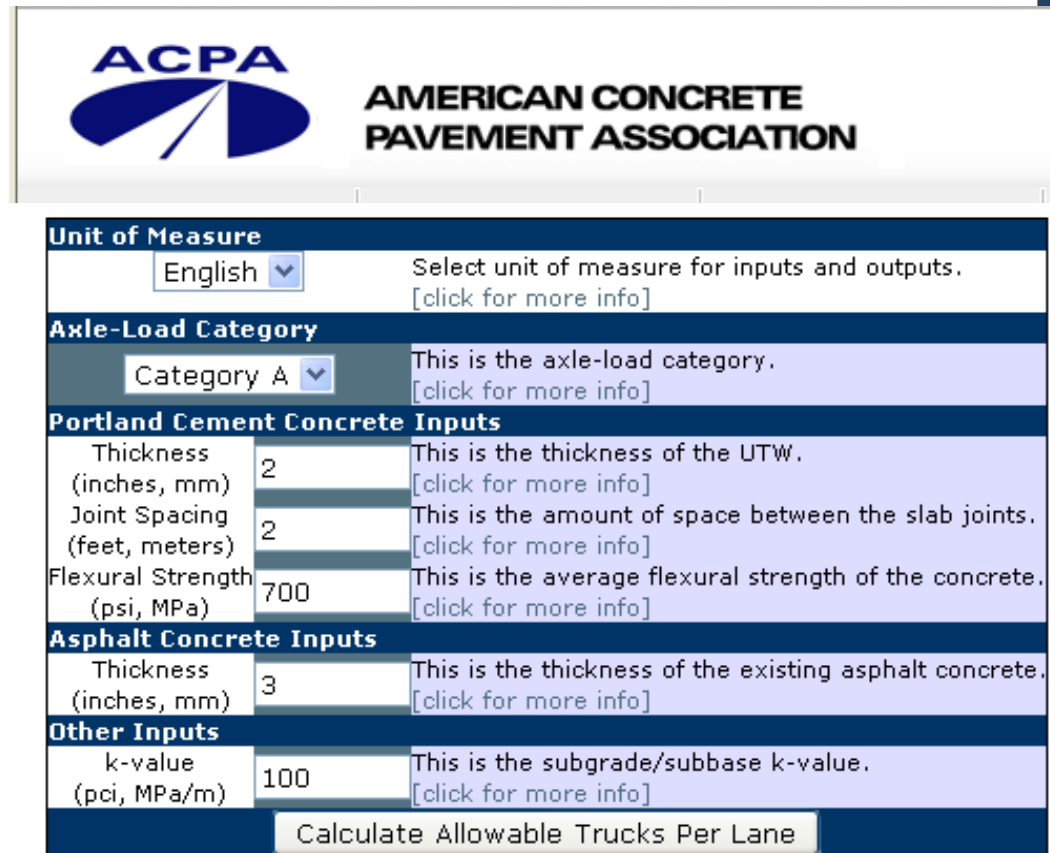
Overlay Type	Typical Design and Software Parameters							
	Traffic (Millions of ESALs)	Typical Concrete Slab Thickness	Maximum Joint Spacing (ft)	Range of Condition of Existing Pavement	Macro-fibers Option (in software)	Transverse Joint Dowel Bars	*Mainline Longitudinal Tie Bars	Recommended Design Procedure
Bonded Concrete Overlay of Asphalt Pavement	Up to 15	3–6 in.	1.5 times thickness (in.)	Fair to Good	Yes	No	No	1, 2, 8

Recommended Design Procedures (see previous page for links)

1. *Bonded Concrete Overlay on Asphalt (BCOA) Thickness Designer (ACPA 2012)*
2. *BCOA ME (Vandenbossche 2013)*
3. Illinois DOT's spreadsheet for bonded concrete inlay/overlay of asphalt design (Roesler et al. 2008)

# Bonded on HMA/Composite: Original ACPA Method

- Web based
- Mechanistic-empirical
  - Fatigue failure (corner loading)
- Conservative
  - High level of reliability



The screenshot shows the ACPA American Concrete Pavement Association web-based design tool interface. It includes a header with the ACPA logo and the text "AMERICAN CONCRETE PAVEMENT ASSOCIATION". Below the header, there are several input sections:

- Unit of Measure:** A dropdown menu set to "English" with a description: "Select unit of measure for inputs and outputs. [click for more info]"
- Axle-Load Category:** A dropdown menu set to "Category A" with a description: "This is the axle-load category. [click for more info]"
- Portland Cement Concrete Inputs:**
  - Thickness (inches, mm):** Input field set to "2". Description: "This is the thickness of the UTW. [click for more info]"
  - Joint Spacing (feet, meters):** Input field set to "2". Description: "This is the amount of space between the slab joints. [click for more info]"
  - Flexural Strength (psi, MPa):** Input field set to "700". Description: "This is the average flexural strength of the concrete. [click for more info]"
- Asphalt Concrete Inputs:**
  - Thickness (inches, mm):** Input field set to "3". Description: "This is the thickness of the existing asphalt concrete. [click for more info]"
- Other Inputs:**
  - k-value (pci, MPa/m):** Input field set to "100". Description: "This is the subgrade/subbase k-value. [click for more info]"

At the bottom, there is a button labeled "Calculate Allowable Trucks Per Lane".

# INPUTS - Bonded on HMA/Composite: BCOA

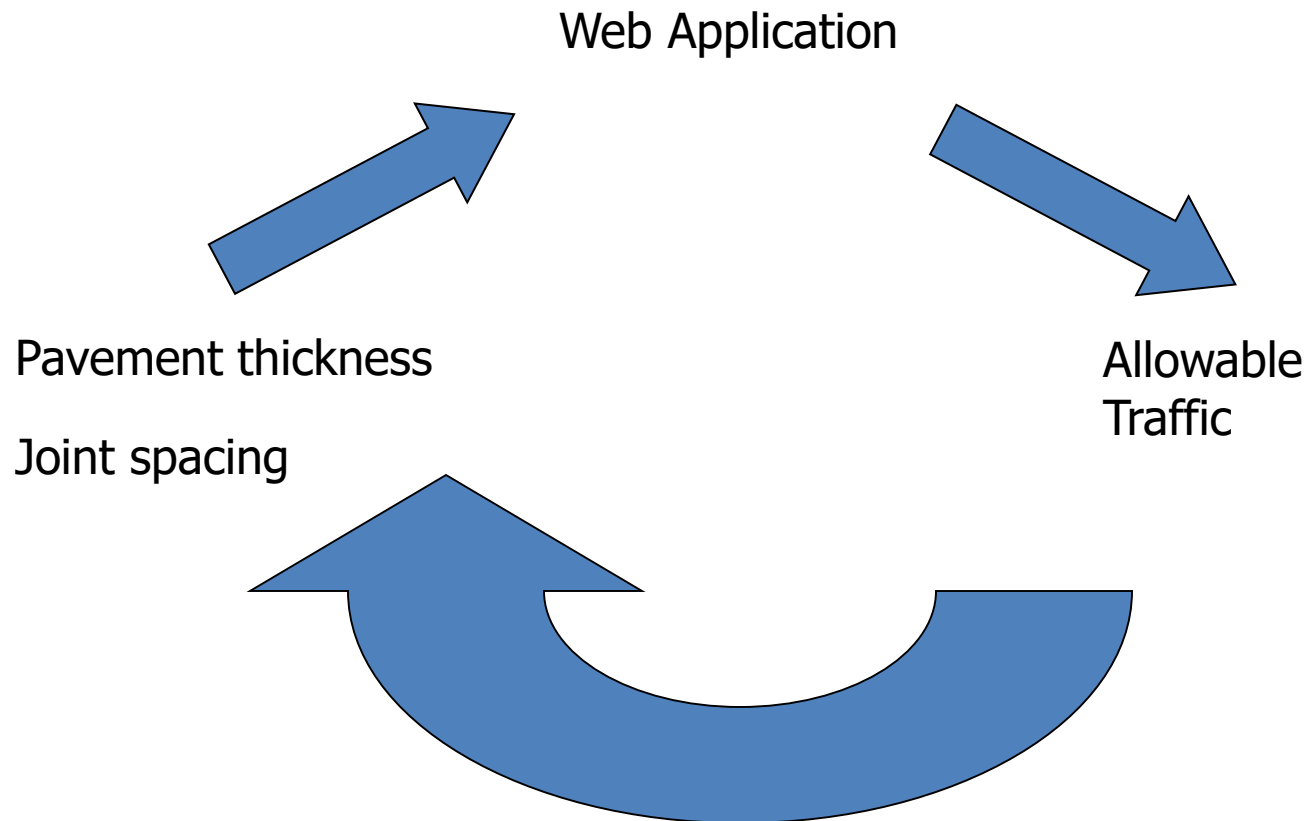
- General Inputs
  - ESALs
  - % Allowable Cracked Slabs
  - Reliability
  - Effective Temperature Gradient and %Time
- Existing Structure
  - Remaining HMA Thickness and Modulus
  - Composite Subgrade/Subbase k-value

# INPUTS - Bonded on HMA BCOA

- Proposed Concrete Overlay:
  - Average 28-day 3rd-point flexural strength
  - Fibers – type
  - Modulus of elasticity
  - Concrete CTE
- Proposed Slab Size and Pre-Overlay Surface Preparation

# Bonded on HMA BCOA

- BCOA is a thickness calculator, but you can adjust design thickness and joint spacing to determine allowable trucks.





*(Last site update Sept. 2013/Last guide update Sept. 2013)*

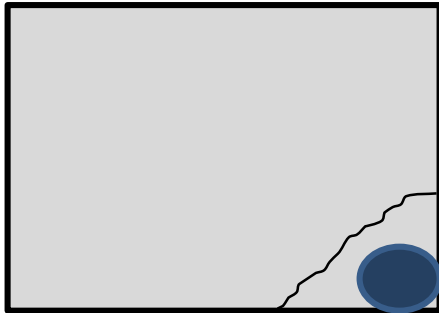
The bonded concrete overlay of asphalt mechanistic-empirical design procedure (BCOA-ME) was developed at the University of Pittsburgh under the FHWA Pooled Fund Study TPF 5-165. This pavement structure has been referred to as thin and ultra-thin whitetopping. This site is a repository for all information relating to the BCOA-ME. The information has been sorted based on its intended use and can be retrieved by clicking on the appropriate tab below. The BCOA-ME can be run directly from this site by clicking on the “Design Guide” tab below.



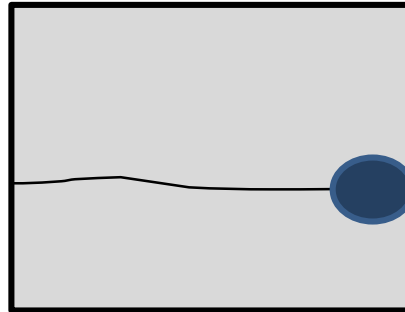
<http://www.engineering.pitt.edu/Vandenbossche/BCOA-ME/>

# BCOA ME failure modes

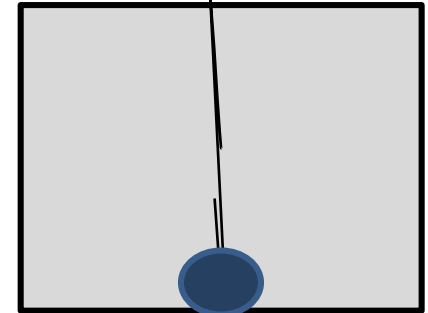
$\leq 4.5$  ft  
**Corner Break**



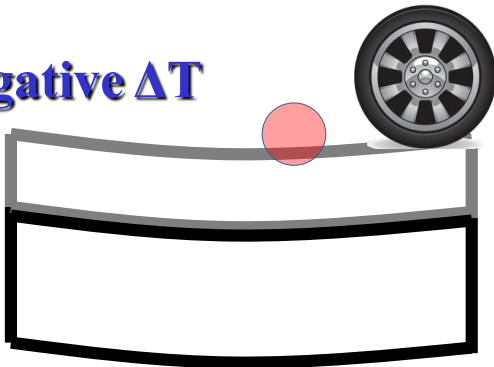
5 to 7 ft  
**Long. & Diag Crack**



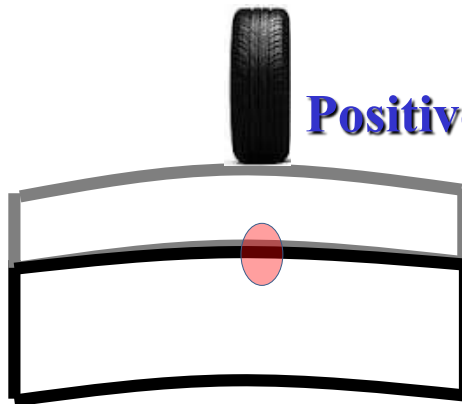
10 x 12 ft  
12 x 12 ft  
12 x 15 ft  
**Trans. Crack**



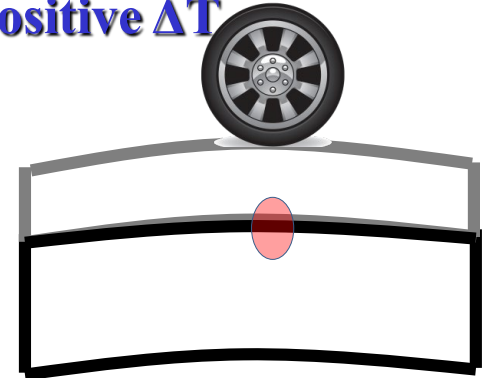
**Negative  $\Delta T$**



**Positive  $\Delta T$**



**Positive  $\Delta T$**



## GENERAL INFORMATION

Latitude (degree):

44.53

Geographic Information

Longitude (degree):

-93.14

Elevation (ft):

874

Estimated Design Lane ESALs:

1000000

ESALs Calculator

Maximum Allowable Percent Slabs Cracked (%):

25

Desired Reliability against Slab Cracking (%):

85

## CLIMATE

AMDAT Region ID

5 ▼

Map of Sunshine Zone

2 ▼

## EXISTING STRUCTURE

Post-milling HMA Thickness (in):

6

HMA Fatigue

Adequate ▼

Fatigue Cracking Example

Composite Modulus of Subgrade Reaction, k-value  
(psi/in):

150

k-Value Calculator

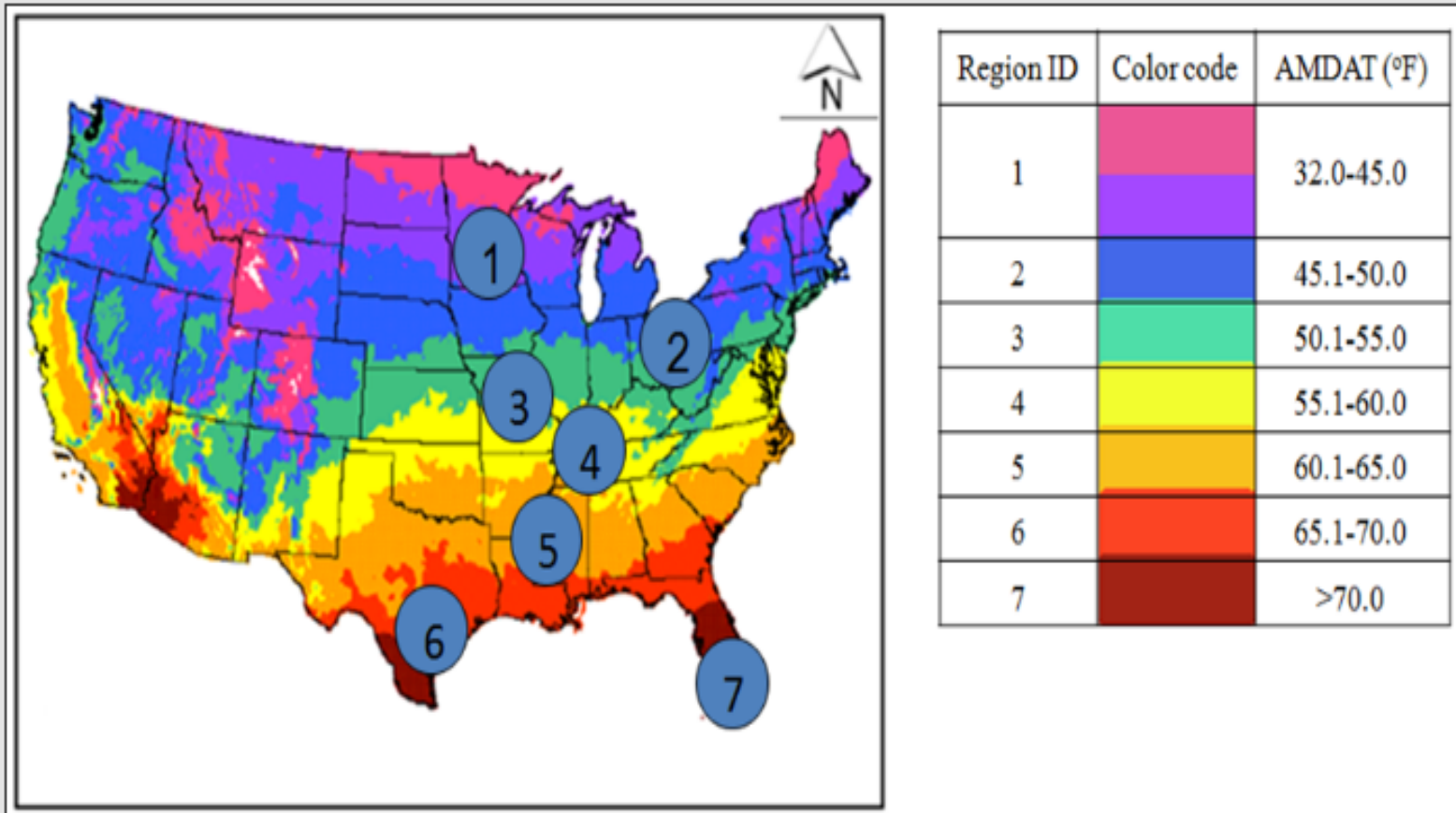
Does the existing HMA pavement have transverse  
cracks?

☒ Yes

☐ No

Transverse Cracking

Fig. 1: Annual mean daily average temperature (AMDAT) map of USA.



→ Back

## PCC OVERLAY PROPERTIES

Average 28-day Flexural Strength (three-point ben

650

Estimated PCC Elastic Modulus (psi):

4000000

[Epcc Calculator](#)

Coefficient of Thermal Expansion (10-6 in/°F/in)

5.5

[CTE Calculator](#)

Fiber Type:

No Fibers

## JOINT DESIGN

Joint Spacing (ft):

6 x 6

[CALCULATE DESIGN](#)

## PERFORMANCE ANALYSIS

Calculated PCC Overlay Thickness (in)

3.84

Design PCC Overlay Thickness (in)

4

Is there potential for reflective cracking?

Yes

Solved.

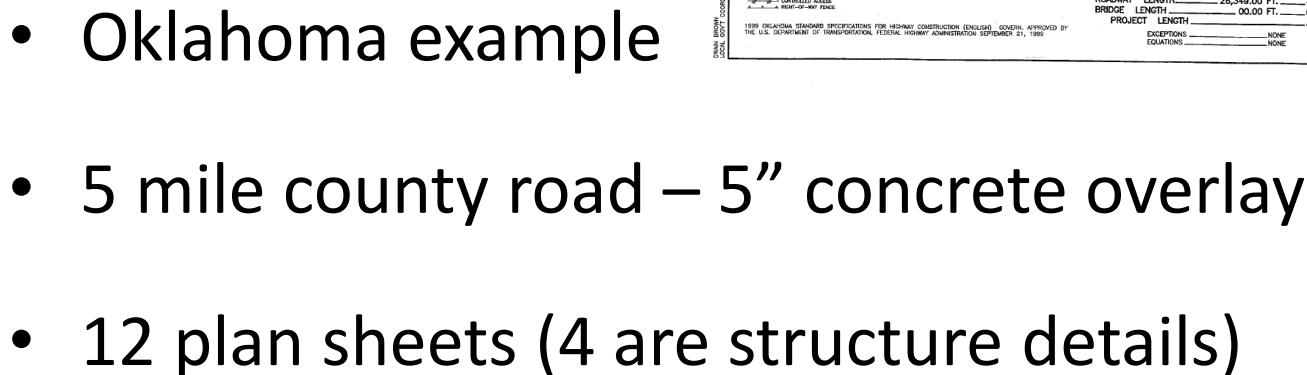


# BCOA

## Design Details and Joints

[illegible]

- For agencies that are inexperienced with the design of concrete overlays, the approach should be similar to that of designing an asphalt overlay.
- The location, geometrics and maintenance of traffic requirements should dictate the level of design detail that is required in the plans.



# Required PCC Overlay Plan Items

- Items to include:

Title sheet and System Map.

Typical Cross Sections.

Estimate of Project Quantities & References

Special Drawings & Tabulations.

Pollution Prevention Plan.

List of Road Standards & Drawings.

Traffic Control Plan Notes & Limitations.

Tabulation of Repairs , Subdrains, Special Events,

# Required PCC Overlay Plan Items

## Continued

- Items to include:

Vertical/Horizontal Control Points (x,y,z).

Profile Tabulation w/Vertical & Horizontal Curve Data Tabulation.

General Staging Notes & Limitations.

Intersection Jointing Plans.

Plan and Profile ( Not always necessary as long as you have reference layout)

# Typical Paving Clearance Zone

- The minimum clearance zone needed for a standard concrete paver operation is 4 ft. (1.22 m) per machine side:
  - This allows 3 ft. (0.91 m) for the paver track/worker
  - 1 ft. (0.30 m) or paver control string line

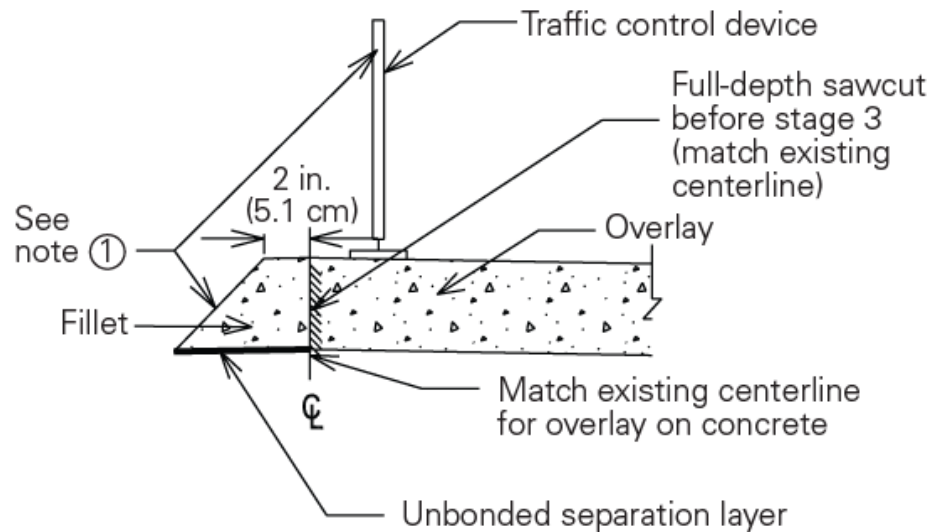


# Staging

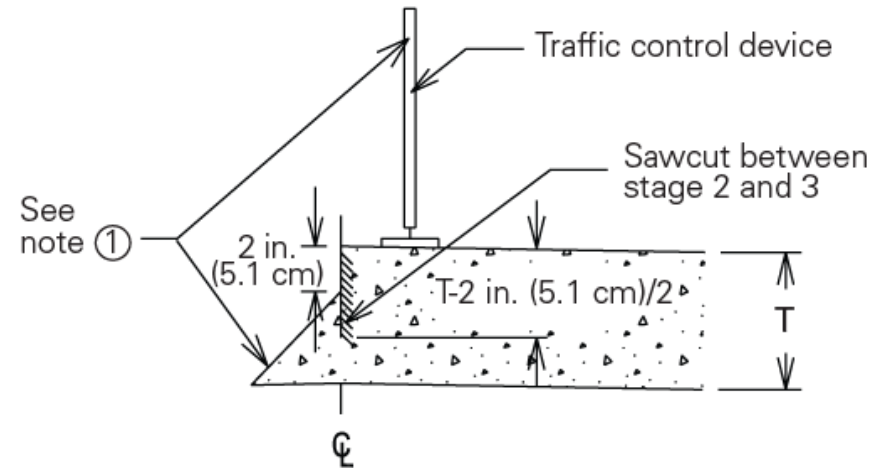
1. Tailor design to meet performance and budget
2. Include appropriate design details
3. Define maintenance of traffic requirements
4. Allow the contractor to those requirements



# Edge Drop Off Fillets



**Bonded overlay 2-4 in. (5.1-10.2 cm) thick**



**Unbonded overlay greater than 4 in. (10.2 cm)**

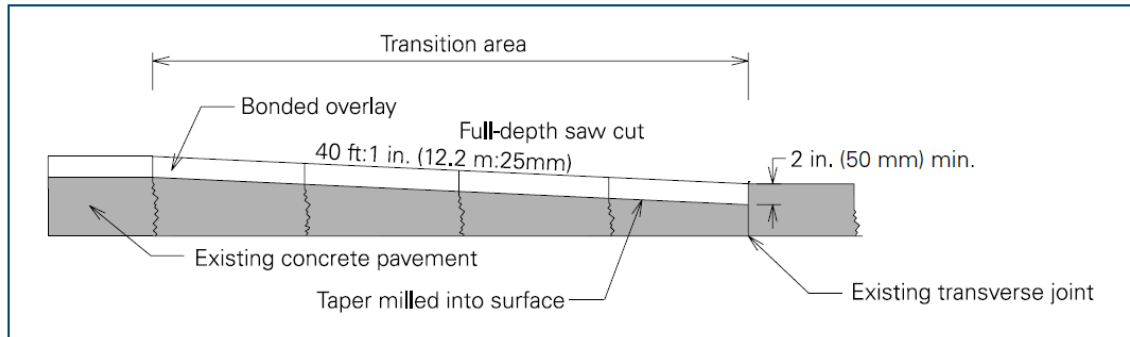
# Cross Section or Grade Correction by Milling

- Milling should be minimized to reducing structural support of the milled pavement.
- Purpose of Milling:
  - Remove distortions 2" or more
  - Reduce significant high spots
  - Increase bond of overlay
  - Meet vertical elevation requirements
- It is preferable to mill to a depth that will minimize the potential for delamination between lifts
- Grade corrections should be made in the thickness of the concrete overlay

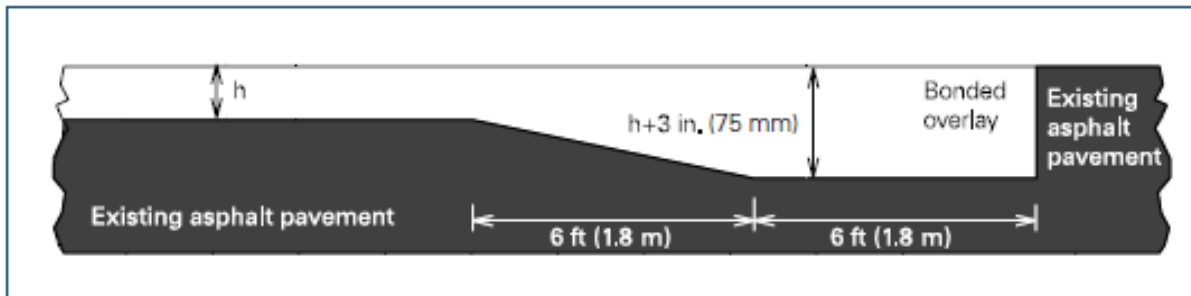
# Mill Surfaced Resulting In Thin Asphalt Lift Issues



# Mill and Fill Transitions



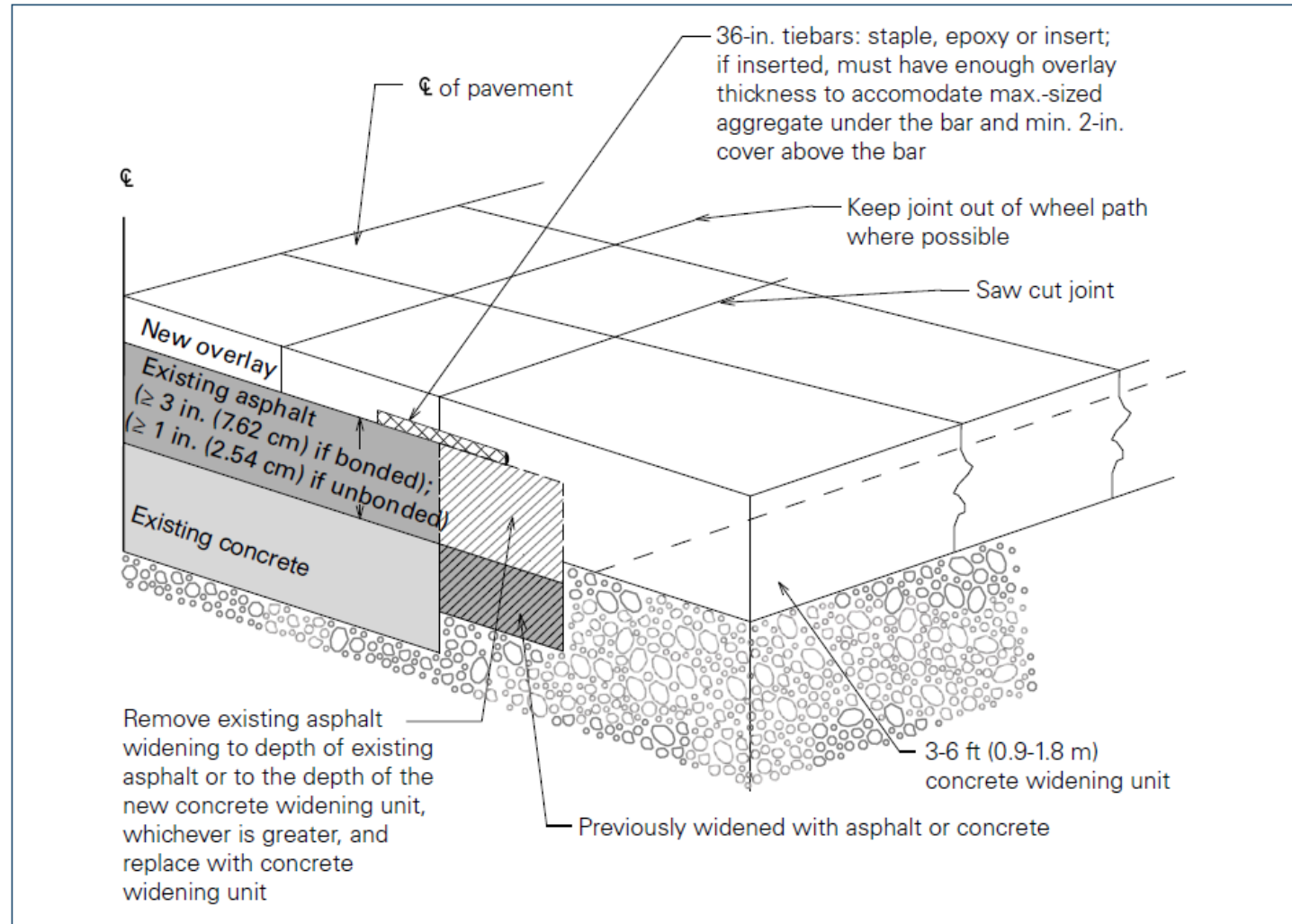
Mill and fill transition for concrete overlay of concrete pavement



Mill and fill transition for concrete overlay of asphalt or composite pavement

# Widening Details

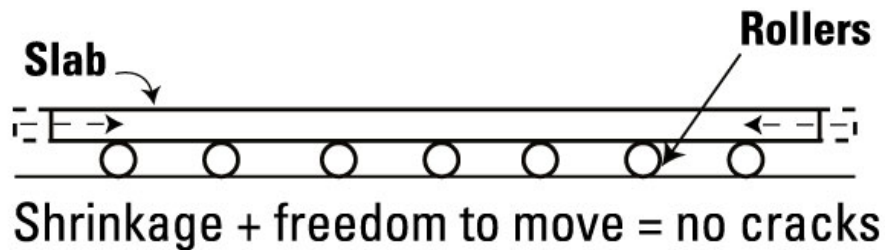
- Widening units



# Joints

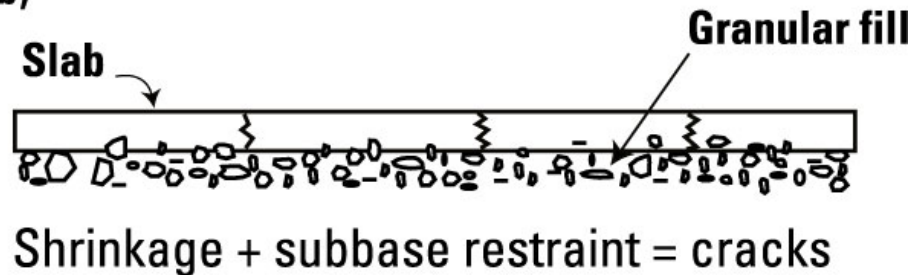


a)



(a) Cracks generally do not develop in concrete that is free to shrink.

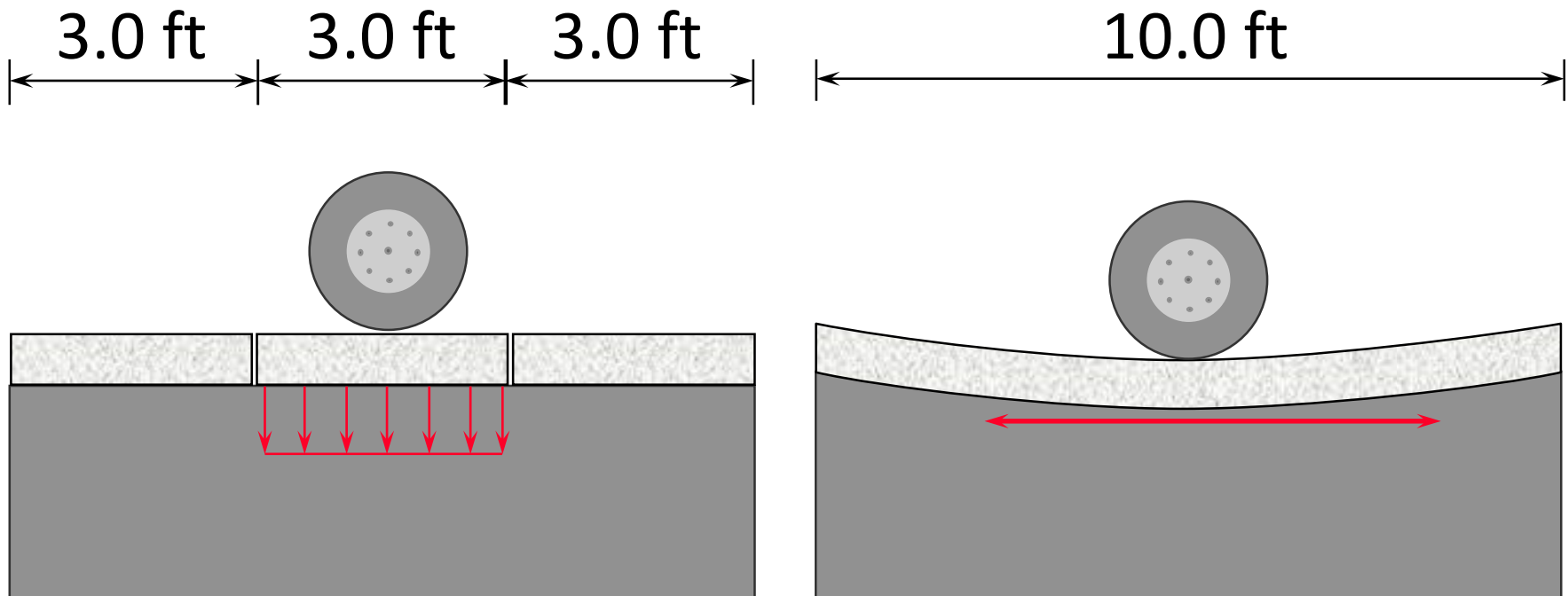
b)



(b) Slabs on the ground are restrained by the subbase, creating tensile stresses that result in cracks.

Not to scale

# Effects of Joint Spacing



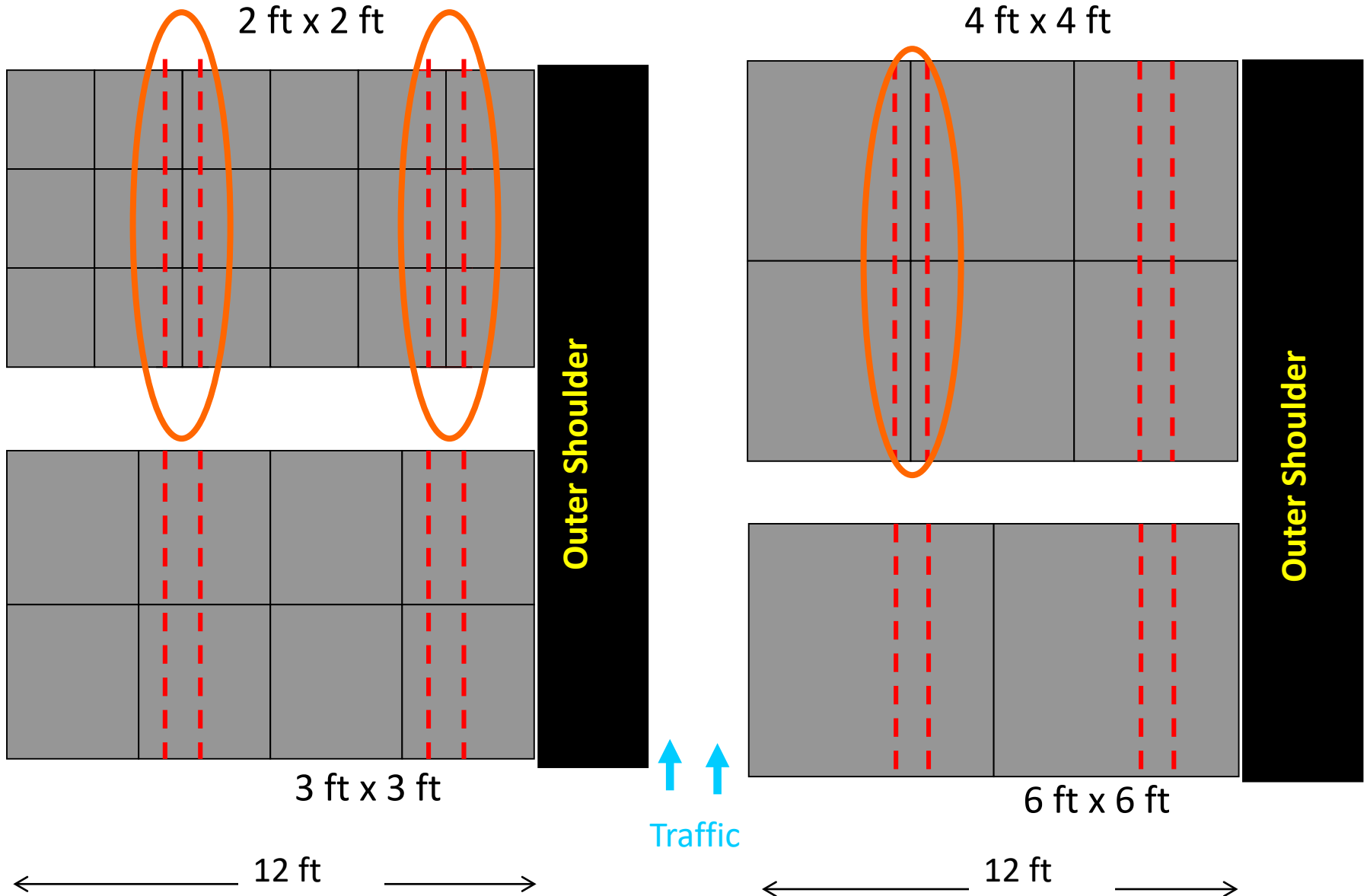
Ultra-thin Slabs Deflect  
*Concrete in Compression*

Standard Slabs Bend  
*Concrete in Tension*

# Joint Spacing for Concrete overlays

Bonded Overlay of Asphalt			
Restriction	Typical Range	Transverse Joint Depth	Longitudinal Joint
Length & width (in feet) at 1.5 times the thickness (inches)	3' – 8'	T/3 min.	T/3

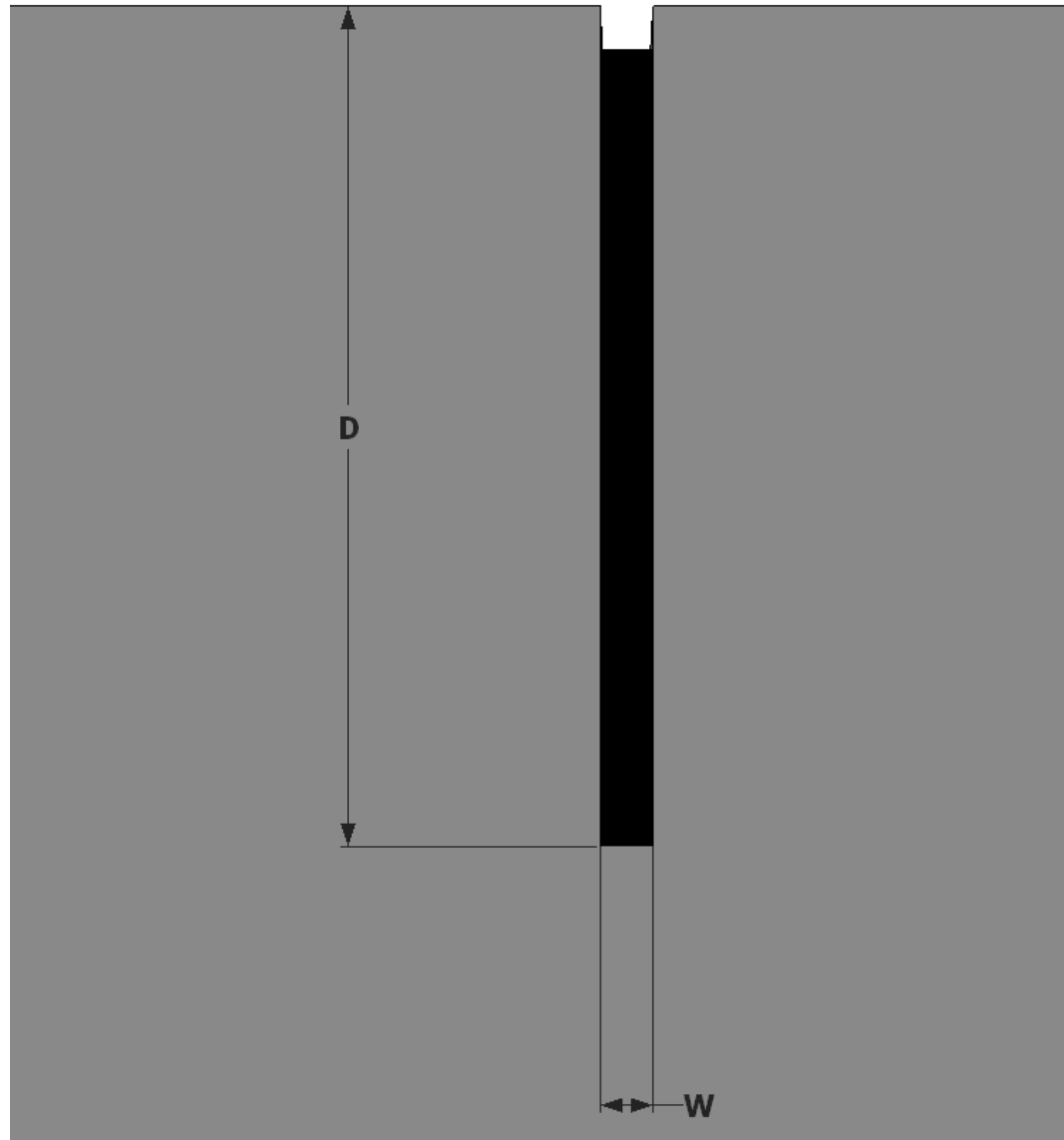
# Longitudinal Joint Layout



# Sealing Joints

- Single sawcut
- Fill with hot pour\*
- Specify the depth
- Require adequate number of saws and blades

\*Need better seal –  
UC Davis Research



# New Observations – *Joint Sealing*



Unsealed Joints

4" PCC = 55% cracked panels  
5" PCC = 8% cracked panels



Sealed Joints

4" PCC = 11% cracked panels  
5" PCC = 11% cracked panels

# ***BCOA Joint Sealing Recommendations Based on MnROAD Cells 60-63***

## **Note: Accelerated loadings**

- PCC Thickness < 5"
  - Layer bonding is more critical than joint deterioration
    - ❖ Recommend sealing joints
    - ❖ Once placed, important to maintain seal
  
- PCC Thickness > 4"
  - Joint condition more critical than layer bonding
    - Sealing optional
    - If sealed, must be maintained. Care to evaluate no seal next to granular shoulders.

# New Observations – *Joint faulting*



Twig, MN

UBOL on HMA interlayer  
12' undoweled panels



Rochester, MN

BCOA  
12' undoweled panels

Currently under study by MnDOT

# Concrete Overlay Construction and Maintenance of Traffic

# Traffic Management- Concrete Overlays

Traffic management for concrete overlay projects is no more challenging than for any other paving project, particularly under traffic, as long as straightforward practices are followed:



# Traffic Management- Concrete Overlays

## Top 20 Elements

1. Traffic Congestion-Capacity analyses-lanes required, length of queues anticipated, large trucks, construction speed, etc
2. Time restrictions—peak hours, seasonal peaks
3. Limits to work areas & local access
4. Detour routes and their capacity
5. Work vehicle access and worker parking
6. Bicycle and pedestrian traffic (urban)
7. Warning sign locations—detours, long queues, intersecting roads
8. Nighttime restrictions, delineation and illumination
9. Signals, turning lanes, bus stops
10. Traffic service—residential/business



# Traffic Management- Concrete Overlays

11. Opening to traffic—maturity, strength requirements, cure time
12. Off-peak traffic hours for increased production
13. Phasing of work—length of work zone, project limits
14. Special conditions such as dropoffs, bridge installation
15. Pre-paving and paving restrictions
16. Short duration closures anticipated
17. Emergency Planning
18. Public information—public meetings with landowners, media,
19. Local officials—police, fire, hospitals, schools, railroads, airports
20. Special events



# Paving

- Maintenance of traffic
  - Depends on concrete overlay thickness
    - If edge drop-off criteria is exceeded, then MOT is just like full depth PCC reconstruction
    - Otherwise, similar to MOT for asphalt projects
  - Options include:
    - Construction adjacent to traffic (lane at a time)
    - Positive separation or cones
    - Pilot car operation for two lane roadways
    - Crossovers and construct full width
    - Staged intersections or full closure with accelerated opening (48 to 72 hr)
  - All concrete overlays are accelerated construction!

# Work Zone

## Cost Effectiveness

- Traffic strategies can significantly affect project costs
- Traffic control costs and construction costs should be balanced against the impact on the public
- Many urban intersections have been overlaid with concrete utilizing only weekend work hours
- Agency sets the criteria regarding staging, contractor proposes staging that meets criteria



# 2 Lane Roadways: Open or Closed for Overlay Construction?

- Always analyze the option of closing road where feasible.
  - Partly or completely closing a work zone to traffic can help minimize traffic management costs.
  - Projects closed to traffic can save time and cost of 25% to 35%.
- Concrete overlays can be successfully and cost-effectively constructed without closing the roadway to traffic
- Contractor is responsible for maintaining local access for residents and businesses.
- Putting the onus on the contractor allows flexibility in their methods for providing local access is a preferred strategy



# Inside Safety Edge Placement



# Inside Safety Material



# Inside Safety Edge Placement Removal



# Preoverlay Repairs on Existing Asphalt Pavement in Preparation for Bonded Overlay

Existing Pavement Distress	Spot Repairs to Consider
Rutting $\geq$ 2 in. (50 mm)	Mill
Rutting < 2 in. (50 mm)	None or mill
Shoving, slippage	Mill
Crack width $\geq$ maximum coarse aggregate size used in the concrete overlay mixture	Fill with flowable fill.
Crack width < maximum coarse aggregate size used in the concrete overlay mixture	None
Low- to medium-severity pothole	Remove loose material and fill integrally with the concrete overlay.
High-severity pothole and/or areas needing full-depth repair	To prevent a single overlay panel from bonding to both asphalt and concrete, make full-depth repairs across a full lane width with concrete and adjust the transverse joint spacing in the concrete overlay to match the location of the underlying patch. The full lane width prevents trying to match a longitudinal joint for a partial lane patch.

# Pre-Paving

- Milling
  - Remove distortions of 2" or more
  - Reduce high spots to insure minimum overlay thickness
  - Match adjacent lanes
  - Enhance bond
  - Minimize vertical grade changes
  - Restore profile
- Bonded on asphalt must maintain a minimum of 3" sound asphalt after milling

# Pre-Paving

- Cautions for milling
  - Milling should be minimized to retain structural support of pavement
  - Grade corrections should be made in the thickness of the concrete overlay



Excessive milling of existing asphalt

# Pre-Paving

- Surface cleaning
  - Power sweeping
  - Air blasting



# Paving

- Maintenance of traffic
  - US-69 Oklahoma
    - Four lane divided
    - One lane at a time
    - Adjacent to traffic



# Paving

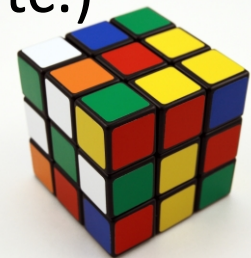
- Maintenance of traffic
  - US-18 Iowa
    - Two lane roadway
    - One lane at a time with a pilot car



# Clearance Challenges

The primary challenges to maintaining reduced clearances are:

- Equipment Clearances:
  - Physical tracks and frame of the slip-form paving machine
  - Traditional paving controls such as use of a string line
- Adequate working area for workers
- Traffic controls for traffic in adjacent lanes
- Traffic Users (vehicles, bicycles, pedestrians, etc.)



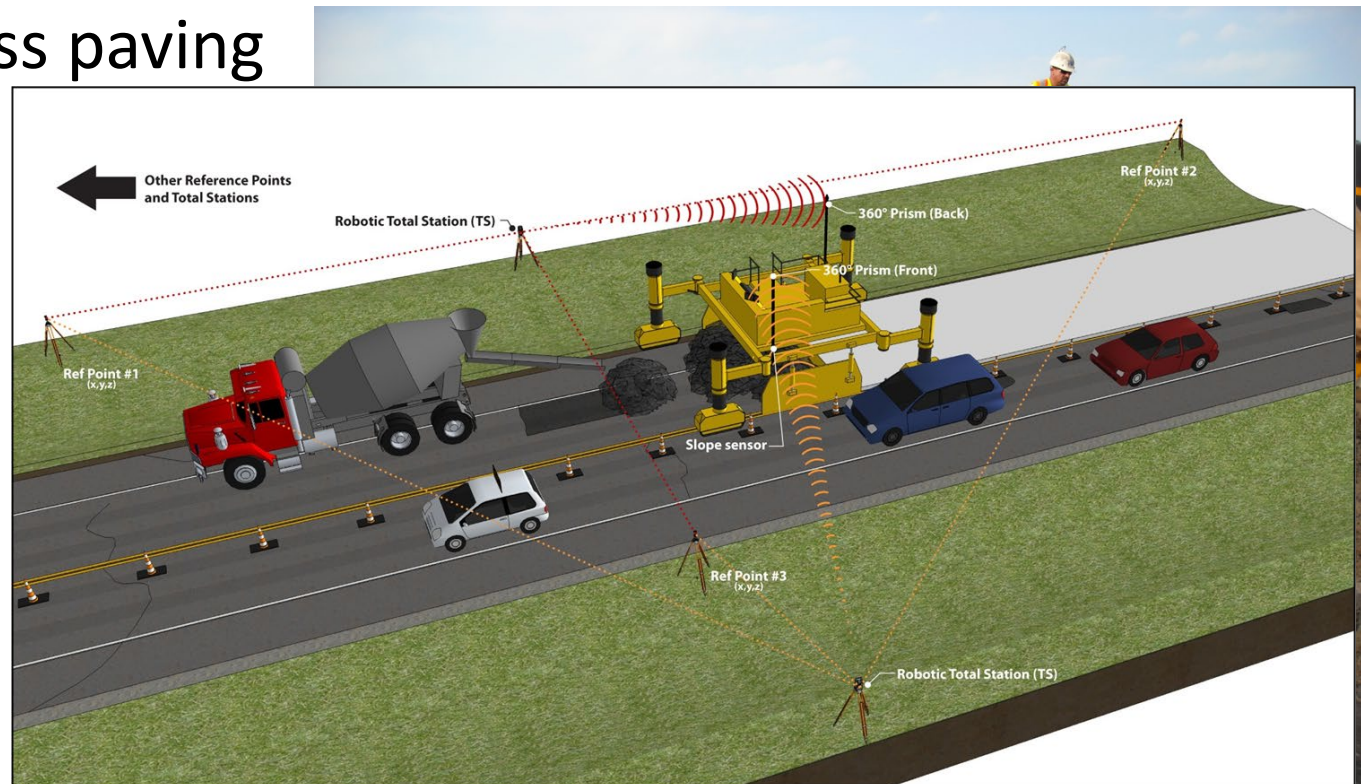
# Reducing Clearances

- Do not specify a particular piece of equipment or method ...
  - Define the maximum allowable clearance zone
  - Allow the contractor to innovate with their equipment and processes



# Clearance Challenges

- Adaptation
  - Moving string (ski)
- Innovation
  - Stringless paving



# Paving

- Stringline
- Stringless – 3D models for existing/milled surface and concrete overlay
- Profiles optimized to balance
  - Thickness
  - Volume
  - Smoothness



# Concrete Overlays

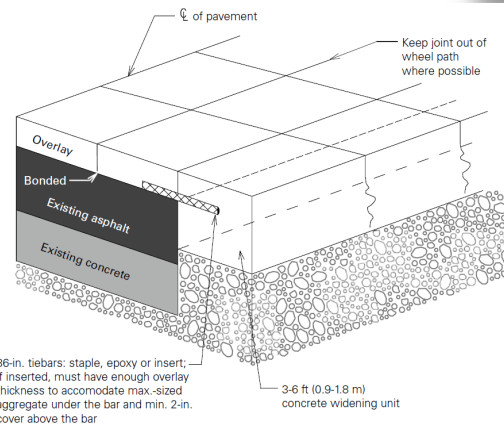
## Accelerated Construction

- Eliminates exposing subgrade to the weather
- Production is typically (or should be) limited by the capacity to saw joints in a timely manner
- Lane rental and A+B bidding with incentives can be used to motivate accelerated opening
- Normal concrete mixtures can and should be used



# Concrete Overlay Placement

1. Pre-paving activities
2. Design and construction details
3. Paving activities



# Paving

- Delivery, spreading, consolidation and initial finishing



# Finishing

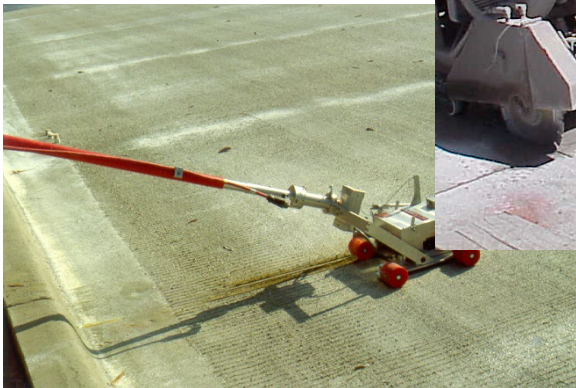
- Increased Finish Area to Volume placed:
  - 12 inch thick 2350 cy = 7050 sy - 1 lane mile
  - 6 inch thick 2350 cy = 14,100 sy - 2 lane miles
  - 4 inch thick 2350 cy = 21,150 sy - 3 lane miles
- Utility structure demand
- Must use a workable mix design:
  - Well graded mixes with SCM's are recommended



# PCC Joint Sawing

## CRITICAL

- Effective curing
- Timely joint sawing



# Sawing

- Volume of saw cuts increased:
- Longitudinal cuts are as critical as transverse
- Increased base friction
- Base movement issues
- Base temperature control
- Mix Temperature control – set times

# Sawing

- Volume of saw cuts increased:

24 foot pavement:

Conventional 16 foot spacing - 13,200 feet/mile

6 x 6 spacing – 36,960 feet/mile

3 times the saw volume

Expanded surface area for same concrete

volume: 12 inch thick = 6756 feet; 6 inch thick =  
37800 feet                      5 ½ times the saw volume

# Cure System



- Too often it is the last thing on our minds
- More critical with admixtures in use today
  - less bleed water
  - more critical with low water cement ratio
  - concrete can dry out and not hydrate
- We need to keep the moisture in the concrete to reduce curl effects
  - Poly-alpha-methylstyrene is worth the premium
  - Lithium silicate reported to reduce cracking

TH-24

Concrete Overlay Project Open House

May 5, 2015

Meeker County Courthouse

Litchfield, MN

9:00 AM to 1:00 PM

# Questions?

## National Concrete Pavement Technology Center

<http://www.cptechcenter.org/>