Guide to Concrete Overlays for Resurfacing & Rehabilitating Existing Pavements





August 7, 2008 – Iowa DOT Seminar

Dale S. Harrington P.E. – Representing CP Tech Center

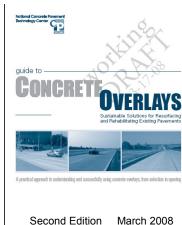
Concrete Overlay Guide

A 80-page "Guide to Concrete Overlay Solutions"

- For Field Application **Program**
- Overview of Overlay **Families**
- Overlay types and uses
- Six Overlay Summaries
- Evaluations & Selections
- Design Section
- Miscellaneous Design Details

- Overlay Materials Section
- -Work Zones under Traffic
- Key Points for Overlay Construction
- -Accelerated Construction
- Project & Specifications Considerations
- 10,000 to be printed





Overlay Committee (17 Members)

- Andy Bennett, Michigan Department of Transportation
- Jim Cable, P.E., Iowa State University
- Dan DeGraaf, Michigan Concrete Paving Association
- Jim Duit, Duit Construction Co., Inc., Oklahoma
- Todd Hanson, Iowa Department of Transportation
- Randell Riley, Illinois Chapter ACPA
- Matt Ross, Missouri/Kansas Chapter ACPA
- Jim Shea, New York State Chapter ACPA
- Gordon Smith, Iowa Concrete Paving Association
- Sam Tyson, Federal Highway Administration
- Leif Wathne, American Concrete Pavement Association
- Jim Grove, CP Tech Center
- Matt Zeller, Concrete Paving Association of Minnesota
- Jeff Uhlmeyer, Washington State DOT
- Kevin Maillard, OHM Advisors
- Robert Rodden, American Concrete Paving Association
- Shannon Sweitzer, North Carolina Turnpike Authority

Why Concrete Overlays?

 Does not require extensive repairs of existing pavement



- Long performance
- High load-carrying capacity
- Well demonstrated/documented maintenance and rehabilitation method
- Effective life-cycle costs

Why are we not using Concrete Resurfacing Technology more?

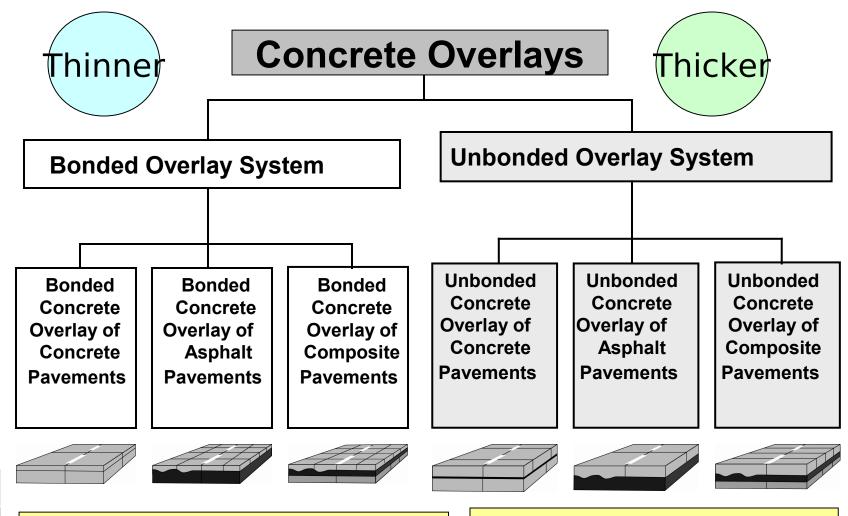
Perception:

- Pavement design theories for bonded and unbonded overlays (resurfacing) are difficult to understand
- There is lack of confidence in overlays because of lack of understanding on how they work
- They are not perceived to be fast track construction like HMA
- Many DOT designers think you must close a roadway to vehicle traffic (particularly two lane roadways)
- They are considered expensive to remove and replace





System of Concrete Overlays

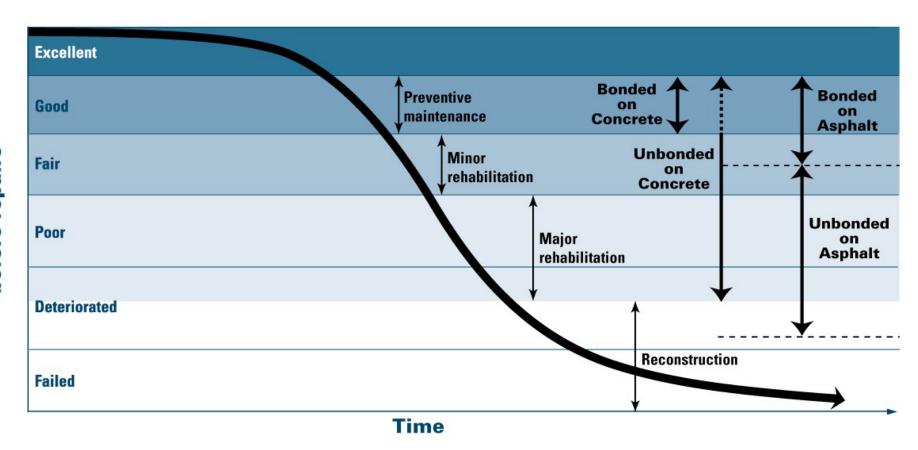




Bond is integral to design

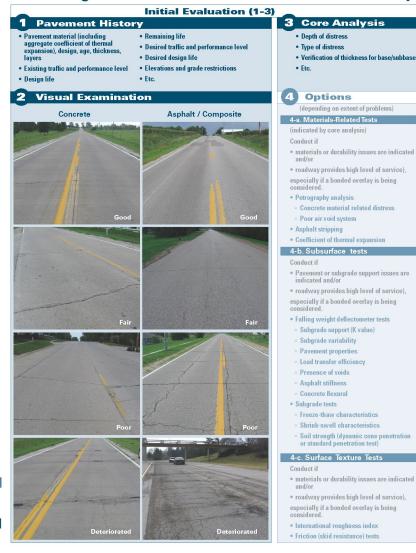
Old pavement is base

Overlay Solutions for Rehabilitation and Maintenance



Pavement Evaluation

Evaluating Pavement Condition for Concrete Overlays -



5 Condition Assessment Profile

Concrete

Surface Deficiencies

- · Friction loss
- - . Map cracking (non-ASR)

 - Noise

 - · Roughness (not distress related)

- - Tented panels

 - Punchout

 - Transverse cracking
 - Subgrade/Subbase Condition

- . Joint deterioration (low to medium) Block cracking
 - Friction loss
- Popouts
- Scaling
- · Plastic shrinkage cracks
- Thermal shrinkage cracks

Structural Deficiencies

- Corner breaks
- · Joint deterioration (severe)
- · Longitudinal cracking
- Pumping/faulting
- Materials-related distress (medium to severe)

- · Etc.

Asphalt / Composite

Surface Deficiencies

- Bleeding/flushing
- Noise
- Corrugation
- · Joint reflective cracking
- · Roughness (not distress related)
- Rutting
- · Weathering/raveling
- Shoving
- Slippage

Structural Deficiencies . Fatigue (alligator) cracking

- Depressions

- Longitudinal cracking
- Potholes
- · Transverse thermal cracking
- · Rutting/shoving
- · Subgrade /Subbase Condition
- Etc.

Condition **Evaluation** Report and **Pavement** Condition **Rankings**





Condition **Evaluation** port md

kings

Pavement History

- Pavement material (including aggregate coefficient of thermal expansion), design, age, thickness, layers
- Existing traffic and performance level
- Design life

- Remaining life
- Desired traffic and performance level
- Desired design life
- Elevations and grade restrictions
- · Etc.





Evaluating Pavement Condition fo

Initial Evaluation (1-

- expansion), design, age, thickness,
- Existing traffic and performance level Elevations and grade restrictions

- Desired traffic and performance level









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Deteriorated

ing/flushing

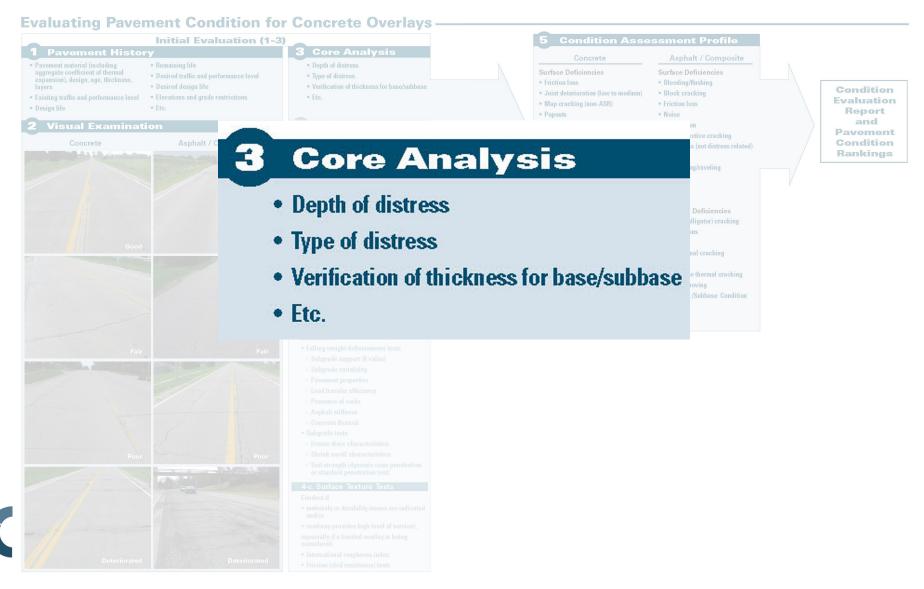
gation

Deteriorated

re (alligator) cracking

g/shoving

Condition **Evaluation** Report and **Pavement** Condition Rankings



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Options

(depending on extent of problems)

4-a. Materials-Related Tests

(indicated by core analysis)

Conduct if

Evaluating Pavement Condition for Concret

expansion), design, age, thickness,

Initial Evaluation (1-3)

- · materials or durability issues are indicated
- · roadway provides high level of service), especially if a bonded overlay is being considered.
- · Petrography analysis
- Concrete material related distress
- · Poor air void system
- Asphalt stripping
- · Coefficient of thermal expansion

4-b. Subsurface tests

Conduct if

- · Pavement or subgrade support issues are indicated and/or
- roadway provides high level of service), especially if a bonded overlay is being considered.
- Falling weight deflectometer tests
- Subgrade support (K value)
- Subgrade variability
- Pavement properties
- Load transfer efficiency
- · Presence of voids
- Asphalt stiffness
- Concrete flexural
- Subgrade tests
- Freeze-thaw characteristics
- Shrink-swell characteristics
- Soil strength (dynamic cone penetration) or standard penetration test)

4-c. Surface Texture Tests

Conduct if

- · materials or durability issues are indicated
- · roadway provides high level of service), especially if a bonded overlay is being considered.
- International roughness index
- · Friction (skid resistance) tests

Condition **Evaluation** Report and Condition Rankings



Evaluating Pave



- Pavement material (including aggregate coefficient of thermal expansion), design, age, thickness layers
- Existing traffic and performance leve
- Design life



Concrete





5 Condition Assessment Profile

Concrete

Surface Deficiencies

- Friction loss
- Joint deterioration (low to medium)
- Map cracking (non-ASR)
- Popouts
- Noise
- Scaling
- · Roughness (not distress related)
- Plastic shrinkage cracks
- Thermal shrinkage cracks
- Etc.

Structural Deficiencies

- Corner breaks
- Joint deterioration (severe)
- Tented panels
- Longitudinal cracking
- Pumping/faulting
- Punchout
- Materials-related distress (medium to severe)
- Transverse cracking
- Subgrade/Subbase Condition
- Etc.

Asphalt / Composite

Surface Deficiencies

- Bleeding/flushing
- Block cracking
- Friction loss
- Noise
- Corrugation
- Joint reflective cracking
- Roughness (not distress related)
- Rutting
- Weathering/raveling
- Shoving
- Slippage
- Etc.

Structural Deficiencies

- Fatigue (alligator) cracking
- Depressions
- Heaves
- Longitudinal cracking
- Potholes
- Transverse thermal cracking
- · Rutting/shoving
- Subgrade /Subbase Condition
- Etc.

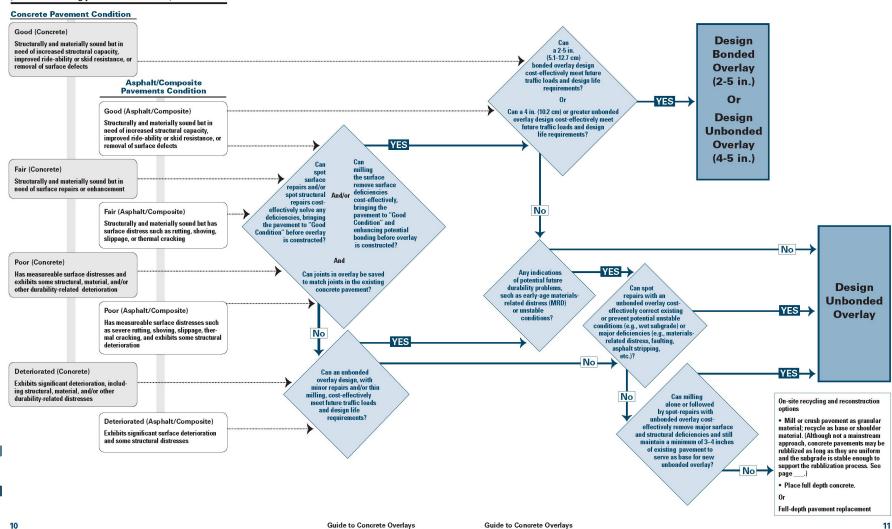
Condition
Evaluation
Report
and
Pavement
Condition
Rankings

Overlay Decision Flow Chart

Pavement Condition Rankings

(based on existing pavement conditions)

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Overlay Decision Flow Chart

Pavement Condition Rankings

(based on existing pavement conditions)

Overlay Decision Flo

Pavement Condition (based on existing pavement condition)

Good (Concrete)

Structurally and materially sound but in need of increased structural capacity, mproved ride-ability or skid resistance, o emoval of surface defects

Asphalt/0

Good (Asphalt/C

Structurally and mat need of increased st improved ride-ability removal of surface d

Fair (Concrete

Structurally and materially sound but in need of surface renairs or enhancement

> Fair (Asphalt/Con Structurally and mat surface distress suc slippage, or thermal

Poor (Concrete

Has measureable surface distresses and exhibits some structural, material, and/or other durability-related deterioration

Poor (Aspha

Has measureable sur as severe rutting, sho mal cracking, and ex deterioration

Deteriorated (Concrete

Exhibits significant deterioration, incluing structural, material, and/or other durability-related distresses

Deteriorated (As

Exhibits signification and some structure

Concrete Pavement Condition

Good (Concrete)

Structurally and materially sound but in need of increased structural capacity, improved ride-ability or skid resistance, or removal of surface defects

Asphalt/Composite Pavements Condition

Good (Asphalt/Composite)

Structurally and materially sound but in need of increased structural capacity, improved ride-ability or skid resistance, or removal of surface defects

Fair (Concrete)

Structurally and materially sound but in need of surface repairs or enhancement

Fair (Asphalt/Composite)

Structurally and materially sound but has surface distress such as rutting, shoving, slippage, or thermal cracking

Poor (Concrete)

Has measureable surface distresses and exhibits some structural, material, and/or other durability-related deterioration

Poor (Asphalt/Composite)

Has measureable surface distresses such as severe rutting, shoving, slippage, thermal cracking, and exhibits some structural deterioration

Deteriorated (Concrete)

Exhibits significant deterioration, including structural, material, and/or other durability-related distresses

Deteriorated (Asphalt/Composite)

Exhibits significant surface deterioration and some structural distresses Bonded Overlay (2-5 in.)

YES ----

Design Unbonded Overlay (4-5 in)

> Design Unbonded Overlay

On-site recycling and reconstruction options

• Mill or crush pavement as granular

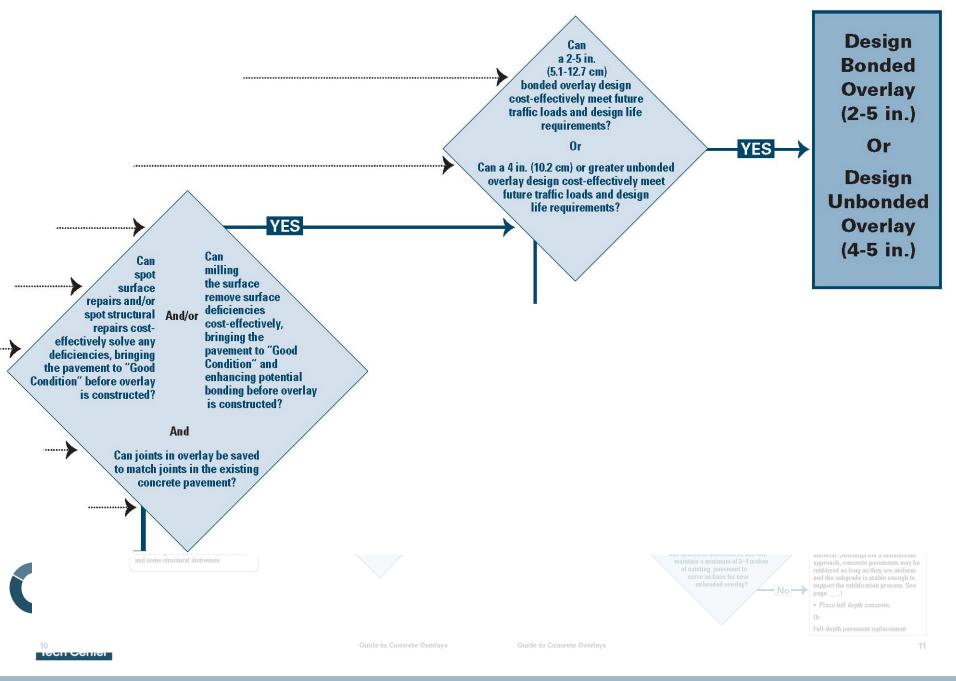
material; recycle as base or shoulder material. (Although not a mainstream approach, concrete pavements may be rubblized as long as they are uniform and the subgrade is stable enough to support the rubblization process. See page...)

Place full depth concrete.

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run-deput pavellient repracellient



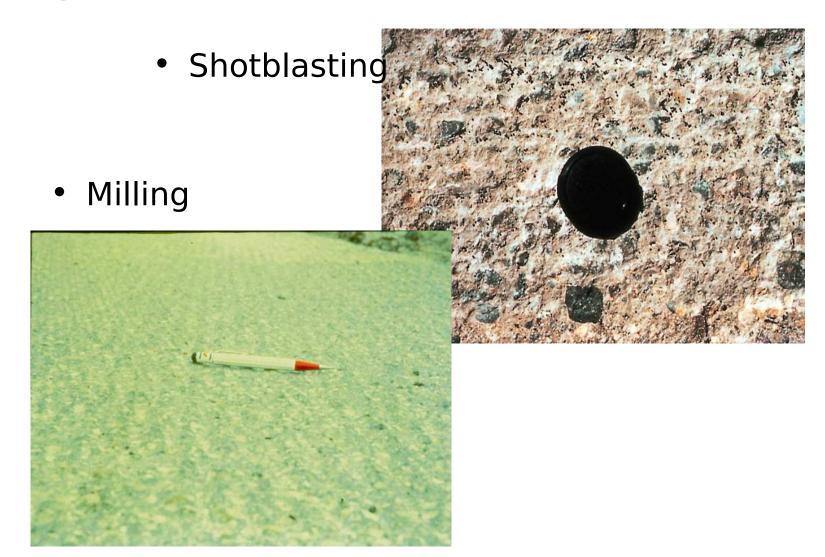


Overlay Decision Flow Chart Pavement Condition Rankings (based on existing pavement conditions) **Concrete Pavement Condition** No No YES **Any indications** of potential future Design durability problems, Can spot such as early-age materialsrepairs with an **Unbonded** related distress (MRD) unbonded overlay cost-YES or unstable effectively correct existing **Overlay** conditions? or prevent potential unstable conditions (e.g., wet subgrade) or No major deficiencies (e.g., materials-YES related distress, faulting, asphalt stripping, etc.)? No YES Can an unbonded overlay design, with minor repairs and/or thin milling, cost-effectively No Can milling On-site recycling and reconstruction meet future traffic loads alone or followed options and design life by spot-repairs with requirements? unbonded overlay cost-• Mill or crush pavement as granular effectively remove major surface material; recycle as base or shoulder and structural deficiencies and still material. (Although not a mainstream maintain a minimum of 3-4 inches approach, concrete pavements may be of existing pavement to rubblized as long as they are uniform serve as base for new and the subgrade is stable enough to unbonded overlay? support the rubblization process. See Nopage ____.) • Place full depth concrete. Full-depth pavement replacement

Important Elements-Bonded Resurfacing of Concrete Clean Surface/Bond is important for good

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

Surface Preparation for Bonded Overlay Bonding is Critical



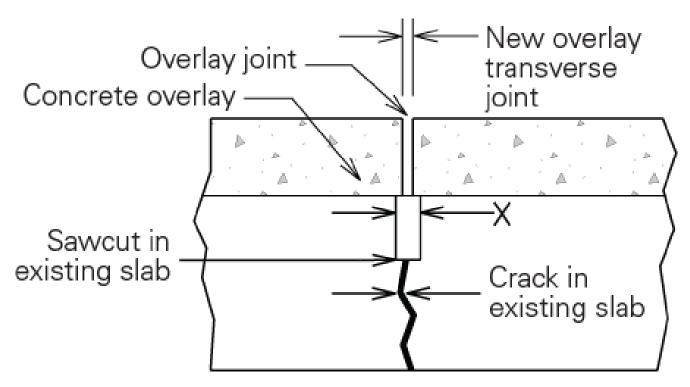


Cleaning the Surface to Prepare for Bonding

- •Sweeping surface followed by compressed air cleaning in front of the paver.
- Air blasting or water blasting is only necessary to remove material that cannot removed any other
- Water or moisture should not be on the surface prior to paving or debonding can occur.







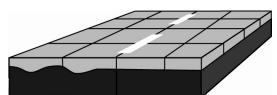


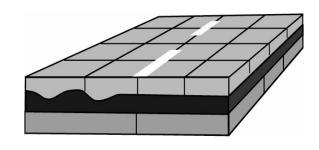
Important Elements of Bonded Concrete over Asphalt/Composite Bonded Concrete Resurfacing of Asphalt

Bonded Concrete Resurfacing of Asphalt Pavements



- 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.



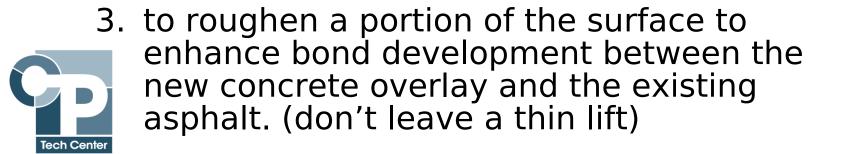




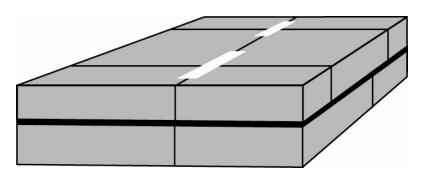
Milling: Bonded Overlay of Asphalt or Composite Pavements

The three main objectives of milling:

- 1. to remove significant surface distortions that contain soft asphalt material;
- to reduce high spots to help ensure minimum resurfacing depth and reduce the quantity of concrete needed to fill low spots;



Important Elements - Unbonded Concrete Overlay 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 overlay from underlying pavement and minimize reflective cracking.
- With heavy truck traffic, adequate drainage design



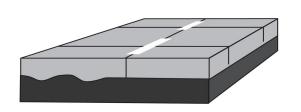
- Shorter joint spacing helps minimize curling and warping stresses.
- No need to match joints with those of the underlying concrete pavement.

Asphalt Separation Layer



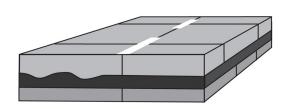


Important Elements - Unbonded Concrete Resurfacing of Asphalt or Composite Pavements • Full-depth repairs are required only



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

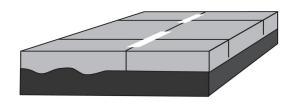




- •Existing pavement profile indicates isolated areas of vertical distortion in the underlying concrete that could signal movement from drainage or material-related distresses, repairs may be necessary.
- •Timing of the joint sawing is important,
 •Concrete patchasing they existing heregartashould be separated from the overlay with a thin layer of fabric or other bond breaker; or joints should be sawed in the overlay around the concrete patch perimeter.



Important Elements - Unbonded Concrete Resurfacing of Asphalt or Composite Pavements





- •Surface temperature of the asphalt layer of the existing composite pavement should be maintained below 120°F when placing overlay.
- Partial bonding between the overlay and the asphalt layer of the existing composite pavement is acceptable and may even improve load-carrying capacity.



Milling of Bonded Concrete







Milling of Bonded Concrete



Concrete Overlays

Payment

Furnished-Cubic Yard



Placement-Square Yard





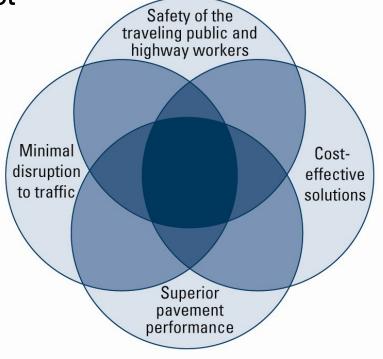
NOTE: Divided payment is the most equitable and economic.

Work Zone Traffic Management

Maintenance and rehabilitation projects that involve bonded and unbonded concrete overlays require:

 Balancing safety and road use demands with cost involves evaluating the requirements and priorities

of the project





Minimize Costs

- Where possible costs can be minimized by:
 - Reducing the frequency that work zones are established
 - Reducing the length of time work zones are in place
 - Reducing the volume of traffic through the work zone (where possible)
 - Decide either close road with detours & crossover



Construct under traffic

Concrete Overlay Staging

- Concrete overlays can be successfully and cost-effectively constructed without closing the roadway to traffic
- A common misperception is that concrete overlay construction on two-lane roadways requires road closures
- Concrete overlays may be constructed on four-lane divided roadways without crossovers and head-to-head traffic

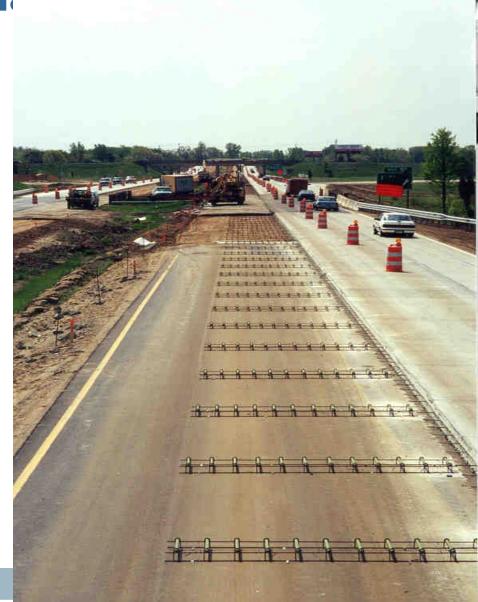




Michigan Strategy-All types of Overlays Unbonded over Asphalt

- Construction of one lane at a time
- Similar to asphalt resurfacing





Michigan Factors

- Less lateral space available during this operation
 - Float operator, inspector, and paver crew need to fit within the new edge of slab and the white edge line
- Batch Truck Movements in and out of traffic
- Ride quality.....harder to obtain high numbers
- Much more time for traffic to get thru project (while paving)
- Edge drop factors
 - Vehicle Traffic is confined to outer edge
 - Potential Soft Shoulder exists at edge
 - Motorists may not be aware of shoulder situation
 - Height of overlay adds to steepness of the pre-existing side slope



Colorado

- Concrete overlay on asphalt 2-lane state highways
- Using pilot car during construction
- 24-hours a day





Colorado Strategy

- Heavily traveled truck routes with heavily rutted asphalt that has potentially driving issues
- One lane construction under traffic
- 70 miles of concrete overlay over asphalt





Concrete Bonded Overlay US 69 in McAlester, Texas





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





Minimum Equipment Clearance

- The minimum clearance 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





Reducing Equipment Clearance

- With adequate planning, required equipment clearances can be significantly reduced in concrete overlay projects and near-zero or zero clearances can be achieved to meet project needs.
- Some paving machine manufacturers have developed special paving machines specifically designed to execute minimum clearance projects







Reducing Equipment Clearance

 Contractors around the country have made various modifications to standard pavers to achieve nearzero to zero (less than 1 ft) clearances





Special Paving Considerations

- Stringline location String was on both sides.
- This also could be done with one string and then cross slope the paver
- Sawing because of a thin section sawing had to be carefully watched,
- Thin section might crack early and 353% more joints to saw than normal paving





Minimum Clearance Four Track Paver





Moving String Line





Reducing Equipment Clearances

- When zero or near-zero clearance is required other paving control options may be used to reduce the clearance distance
- The average profiler, a movable string line, or a ski can be used in tight areas
- These methods rely on the smoothness of an existing lane for their smoothness or lack thereof



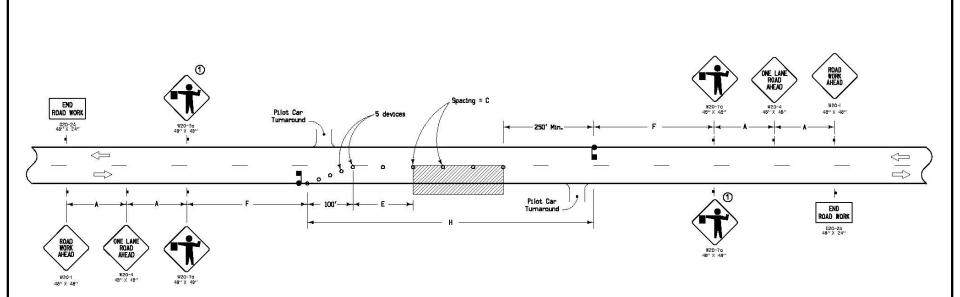




Two-Lane Highway Under Traffic

- Typically traffic control zones are kept to 0.25 mile (0.4 km) in length without the use of a pilot car
- In rural areas it is more feasible to pave longer sections, so a pilot car and flaggers are often used
- Other traffic control measures including flaggers and traffic control signals may be warranted according to jurisdictional requirements





LEGEND

Traffic Sign

Flagger

o 42" Channelizer or Vertical Panel



C Direction of Traffic

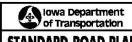
SPEED LIMIT (mph)	ADT	A	С	E	F	(2) H max.
35 or less	up to 2,500	250'	40'	100'-200'	500'	2.5 m1.
	2,500 - 5,000	250'	40'	100'-200'	500'	2.0 mi.
	more than 5,000	500′	40'	100'-200'	1000'	L.5 m1.
40 - 45	up to 2,500	350'	801	100'-200'	700'	2.5 mi.
	2,500 - 5,000	350'	80'	100'-200'	700'	2.0 mi.
	more than 5,000	700′	80′	100'-200'	1400'	1.5 mi.
50 or greater	up to 2,500	500'	80'	200'-300'	1000'	2.5 mi.
	2,500 - 5,000	500'	80'	200'-300'	1000′	2.0 mi.
	more than 5,000	1000'	80'	200'-300'	2000'	1.5 mi.

A pilot car will be required when the length of the work area exceeds one-quarter mile on primary highway projects.

- ① Sign optional for ADT less than 5,000.
- ② In rural areas during non-peak hours, the contractor may extend the lane closure up to 1.0 mile beyond the maximum shown in the table. Once the traffic control devices have been placed to extend the lane closure, the movement of the devices shall progress downstream until the H distance is once again within the limit shown in the table.

Contract Items:

Traffic Control Flaggers Pilot Cars



1 10-16-07 **TC-214**SHEET 1 of 1

STANDARD ROAD PLAN

REVISIONS: Added spacing column E to table, thenged spacing to 80' for higher speeds.

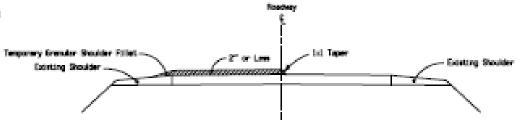
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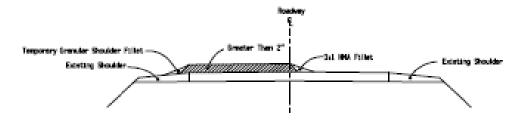
LANE CLOSURE
WITH FLAGGERS AND PILOT CAR

TC-282

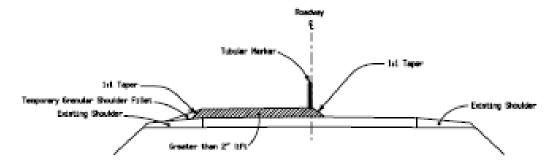
DESIGN LIFT THICKNESSES 2" OR LESS



DESIGN LIFT THICKNESSES GREATER THAN 2" (WITH FILLET)

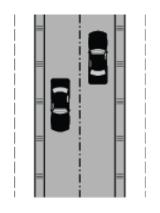


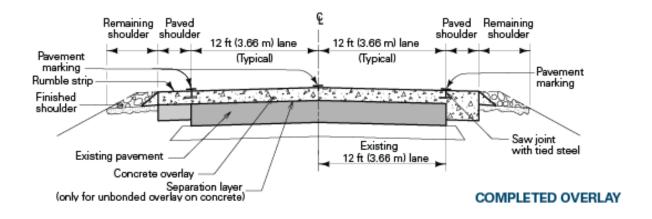
DESIGN LIFT THICKNESSES GREATER THAN 2" (WITHOUT FILLET)

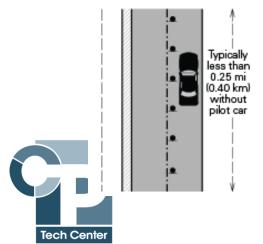


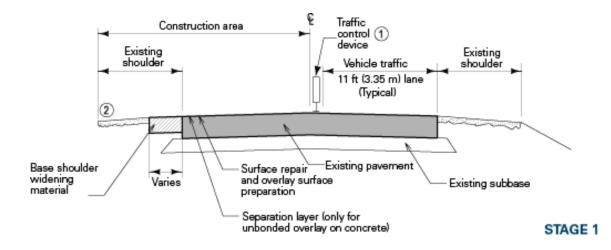


Overlay of Two-Lane Roadway with Paved Shoulders (Conventional Paver)

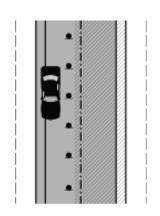


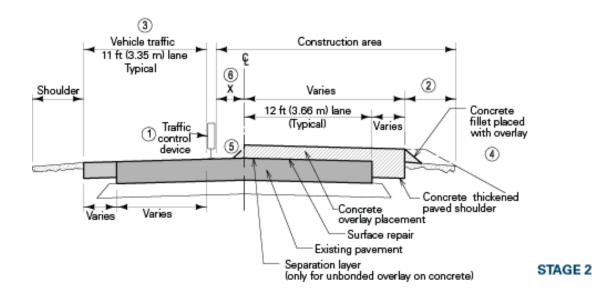




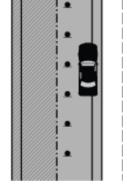


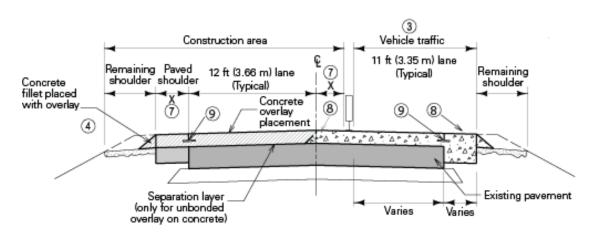
Overlay of Two-Lane Roadway with Paved Shoulders (Conventional Paver)

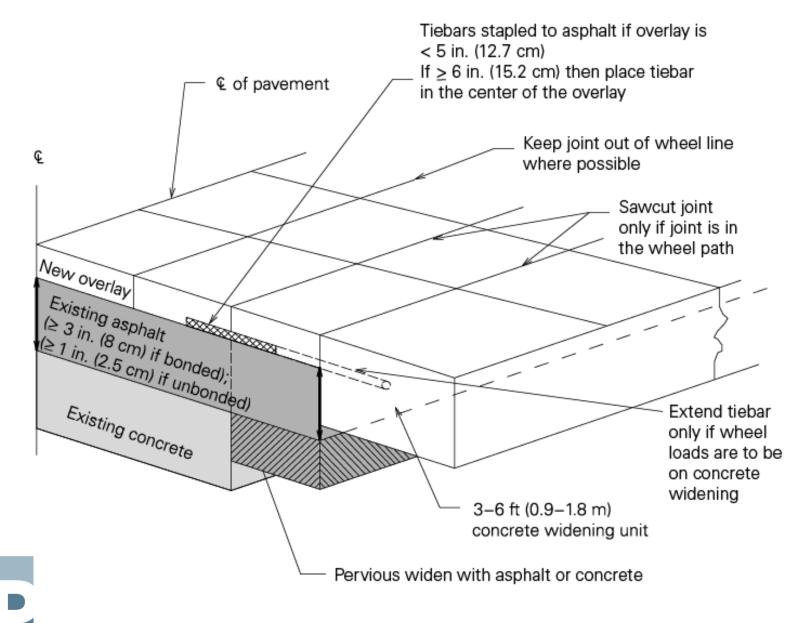








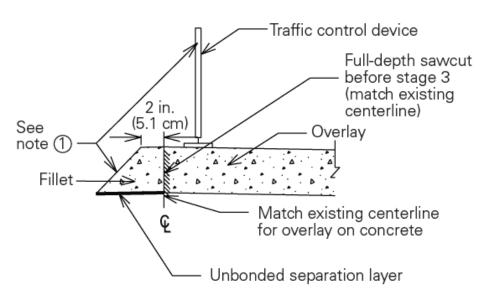




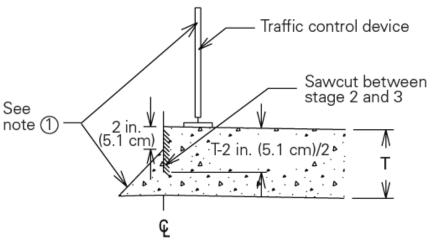


Tech Cente

Edge Drop Off Fillets



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



Unbonded overlay greater than 4 in. (10.2 cm)



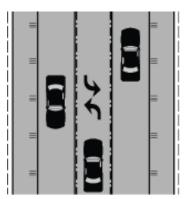
Colorado Overlay "6x6"

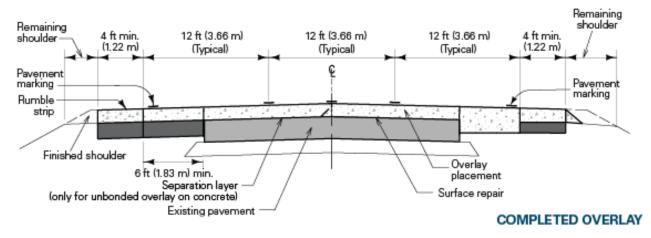


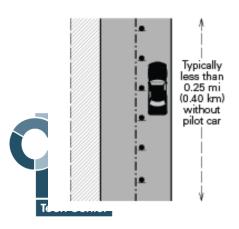


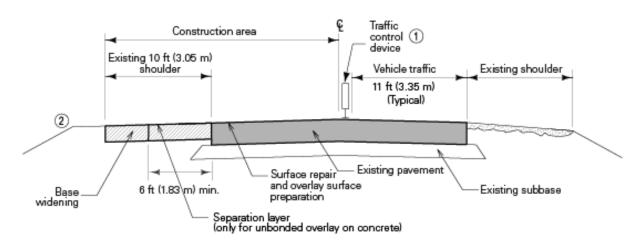


Overlay of Two-Lane Pavement Widening to Three Lanes with Paved Shoulders (Conventional Paver)

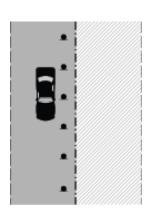


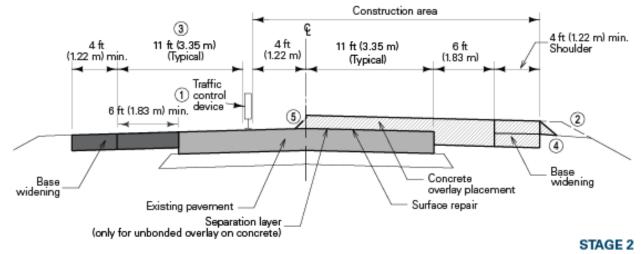


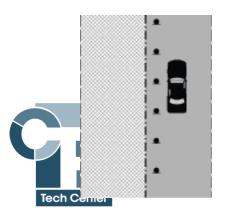


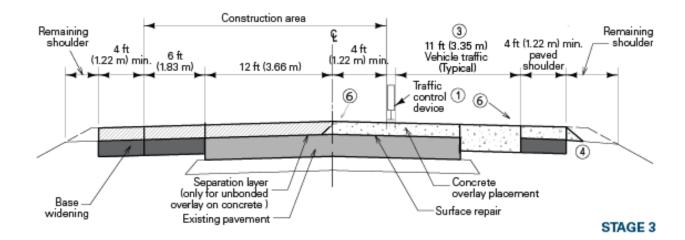


Overlay of Two-Lane Pavement Widening to Three Lanes with Paved Shoulders (Conventional Paver)

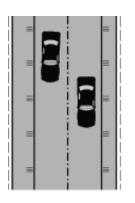


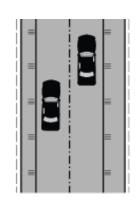


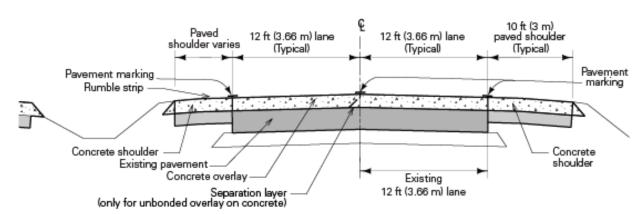




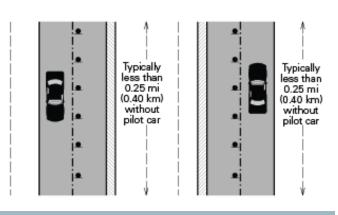
Overlay of Four-Lane Roadway with Paved Shoulders (Conventional Paver)

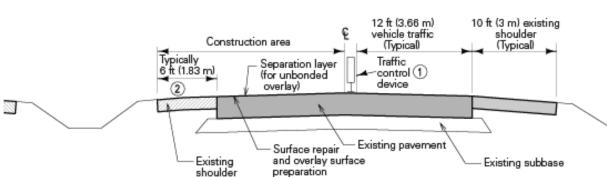




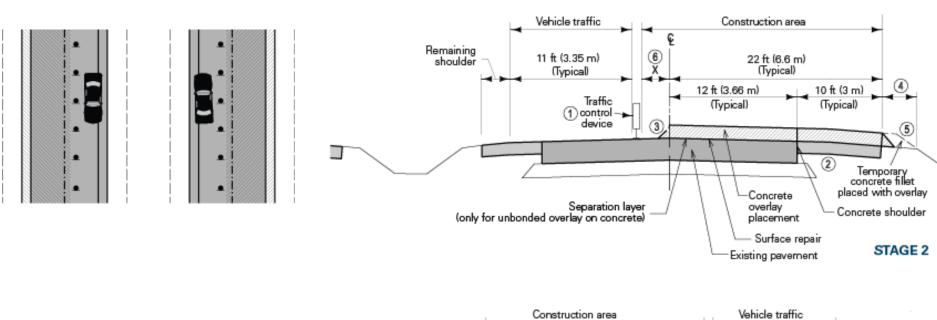


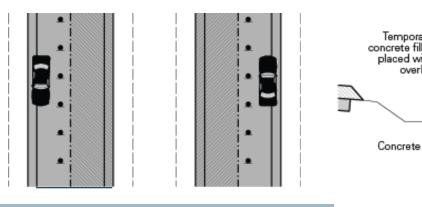
COMPLETED OVERLAY

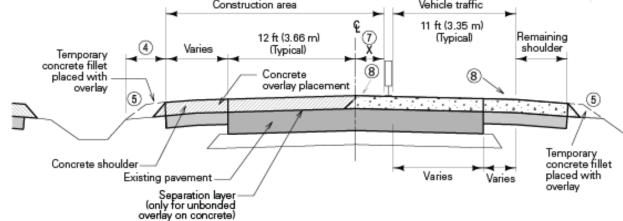




Overlay of Four-Lane Roadway with Paved Shoulders (Conventional Paver)







STAGE 3

THANK YOU!

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