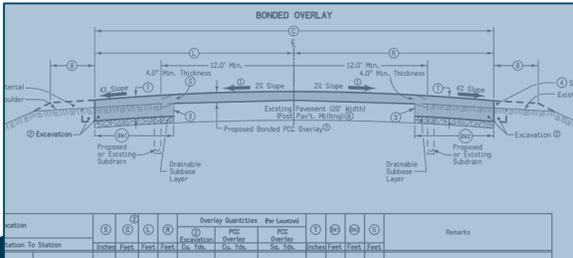
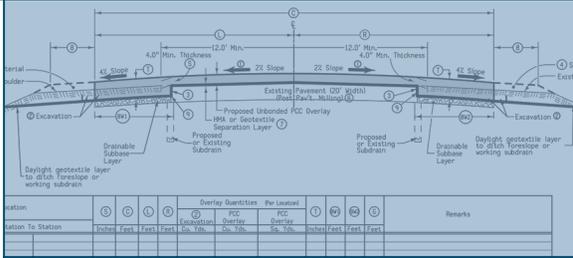


Development of Concrete Overlay Construction Documents

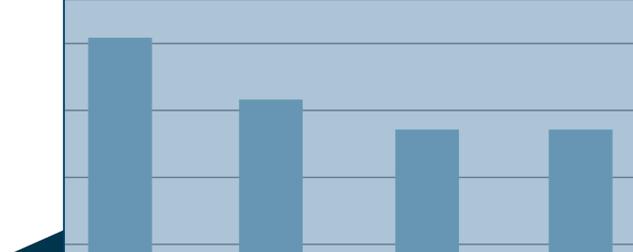


Material or Construction Item	Tests
Fine Aggregates	Gradation
	Moisture
	Specific Gravity
Coarse Aggregates	Gradation
	Moisture
	Specific Gravity
Portland Cement	Quality
Fly Ash	Quality
GGBFS	Quality

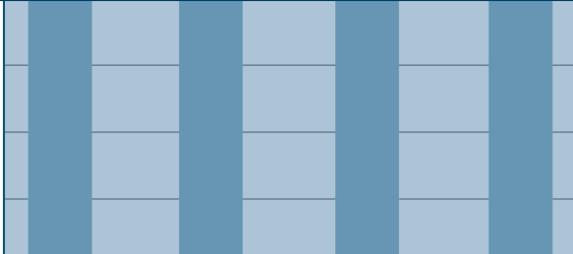
STANDARD DRAWINGS **GUIDE SPECIFICATIONS**



Curing Compound	Quality
Joint Sealer	Quality
Epoxy Dowel Bars and Assemblies	Quality
Tie Bars	Quality
Plastic Concrete	Air Content
	Slump
	Cylinders 6in.
	Beams
	Thickness
Hardened Concrete	Smoothness
	Thickness ²
	Strength



COSTS **LESSONS LEARNED**



About the National CP Tech Center

The mission of the National Concrete Pavement Technology (CP Tech) Center at Iowa State University is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

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About this Guide

Purpose

The purpose of this document is to provide guidance for the development of a concrete overlay project. This guide includes sample construction drawings, the information needed on guide specifications, information on costs, and details on design lessons learned.

Developing a Concrete Overlay Project

Concrete overlays have proven to be a successful and feasible preservation method providing additional life for a roadway pavement. In order to be successful, a thorough evaluation process is critical to choosing the proper overlay type.

Bonded concrete overlays restore the structural capacity of the original roadway. They are designated for pavements in fair to good condition. Unbonded concrete overlays improve the pavement structure and load carrying capacity. Both types of concrete overlays offer good rehabilitation solutions for pavements in moderately deteriorated to poor condition.

Construction Drawings

How do you develop a set of construction drawings for a concrete overlay? This guide provides the details needed along with typical starter construction plan sets that you can download from <http://www.cptechcenter.org/research/research-initiatives/overlays/>. In addition, .DWG files for use with your CAD program are available upon request.

Often, too much emphasis is placed on displaying the road profile. This leads to drawing sets that are large, cumbersome, and costly to develop. The drawing sets for concrete overlays can be developed without road profiles and multiple plan views. Concrete overlay construction drawings should be smaller and less costly to develop than a drawing set for a reconstructed pavement for example. The drawings provided for download with this guide include standard details and commentary, which can be customized for a specific project.

Guide Specifications

To supplement the construction drawings, the National Concrete Pavement Technology (CP Tech) Center's *Guide Specifications for Concrete Overlays* are referenced with an overview on how to use them and what they include. The development of these guide specifications were a result of the Federal Highway Administration (FHWA) pooled fund Next Generation Concrete

Pavement Road Map (TPF-5(286)). Five states, including Georgia, Iowa, Michigan, Oklahoma, and Pennsylvania, were instrumental in the development of the guide specifications.

The specification format follows that of an agency's standard specifications for concrete pavement and uses a common three-part structure, including General Information, Products, and Execution. A public agency can use this guide in developing supplemental specifications or special provisions related to its own concrete pavement specifications.

Cost

What will a concrete overlay cost? With the assistance of eight states (Colorado, Illinois, Iowa, Michigan, Minnesota, Missouri, Oklahoma, and South Dakota), construction costs from 36 concrete overlay projects were compared. Project information including name, date, location, thickness, overlay type, joint spacing, and separation layer type was collected. The costs are representative of concrete overlay pavement furnishing and placement.

Common comparisons such as cost per square yard per inch and costs per mile were compiled.

Non-direct costs including milling, subdrain, traffic control, and mobilization are not included in this cost summary. However, using the information provided, a realistic budget can be determined.

Design Lessons Learned

To provide a high performing concrete overlay, it is beneficial to be aware of lessons learned from previous projects. For example, on concrete overlays with widening or paved shoulders, it is critical to note design guidance that can reduce the potential for longitudinal cracking along the edge of the pavement. Design lessons learned include the following:

- Provide adequate drainage in support layer of concrete overlay widening
- Include special consideration to tie bar placement in the overlay widening
- Include adequate thickness for concrete overlay widening
- Design for proper placement of longitudinal sawcuts between the concrete overlay mainline and widening

Section 1. Developing a Concrete Overlay Project

Getting Started

This guide includes essential items needed to design and construct successful concrete overlay projects: examples of construction drawings, specification guidance, cost information, and design lessons learned. Before developing a concrete overlay project, the existing pavement must be evaluated, and the proper type of overlay must be chosen. The National Concrete Pavement Technology (CP Tech) Center's *Guide to Concrete Overlays* (at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf) provides the information necessary to evaluate a pavement.

The five-step evaluation process consists of the following:

1. Pavement history review
2. Visual examination of pavement
3. Core analysis
4. Optional analysis (material related, subsurface, surface texture tests)
5. Condition assessment profile

Concrete overlays share at least two key design requirements with on-grade concrete pavements to achieve satisfactory performance:

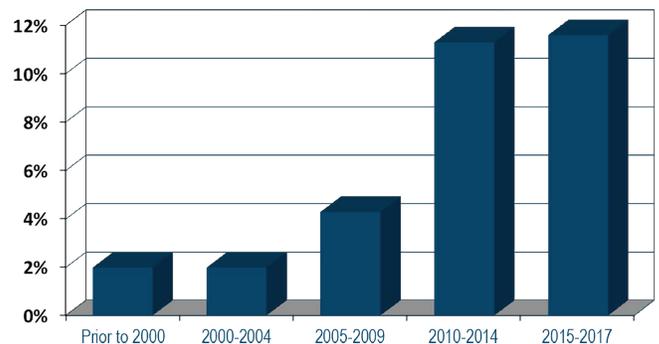
- Uniform support conditions
- Effective control of movement

Nearly all of the documented cases of premature overlay failures can be traced to some violation of these two requirements. Often, premature failure can be attributed to choosing the wrong overlay (bonded vs. unbonded) to design or construct. The evaluation of existing pavement is critical in determining if uniform support and movement control exists (for unbonded overlays) or if the underlying pavement can be cost-effectively repaired or milled to remove surface deterioration (for bonded overlays).

History and Growth

Concrete overlays have been in existence for more than 100 years. Since 1901, thousands of miles of

state primary and county roads have been successfully rehabilitated with concrete overlays. From 2009 through 2010, the use of concrete overlays has increased dramatically. Figure 1 shows the percentage of concrete overlays as compared to total concrete paving.



After Voigt 2017, ACPA, used with permission

Figure 1. Concrete overlays as a percentage of total concrete paving (yd²)

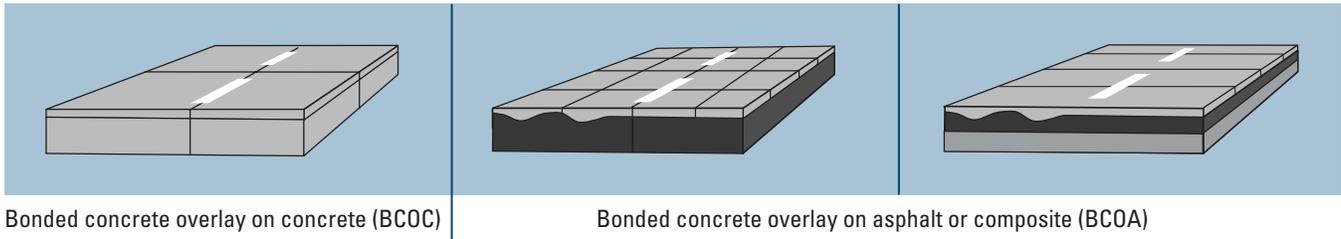
From 2009 through 2016, an average of 7 million square yards per year have been placed in the US according to the American Concrete Paving Association (ACPA).

With technological advancements and sharing of technical knowledge, concrete overlays continue to grow in popularity and are a feasible and sustainable pavement rehabilitation method.

Bonded Concrete Overlays

Bonded concrete overlays primarily serve as a preventive maintenance tool or minor rehabilitation strategy to restore the structural capacity where major rehabilitation is not required. However, there are some situations where the existing pavement needs slightly increased structural capacity due to additional traffic loading. In these circumstances, the additional loading is handled by the design thickness of the bonded overlay.

A bonded overlay is designed to behave as a monolithic slab with the existing pavement. The existing pavement is a critical part of the improved pavement system. Therefore, the existing pavement must be in fair to good condition for a bonded overlay to be successful. See Figure 2 for types of bonded concrete overlays.

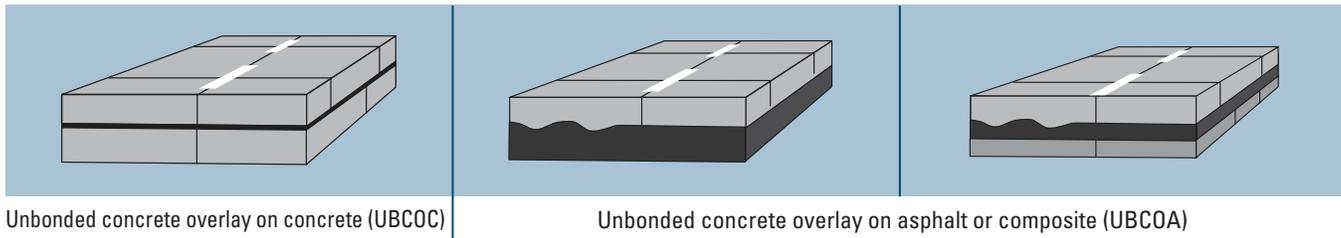


Bonded concrete overlay on concrete (BCOC)

Bonded concrete overlay on asphalt or composite (BCOA)

Figure 2. Bonded concrete overlays

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Unbonded concrete overlay on concrete (UBCOC)

Unbonded concrete overlay on asphalt or composite (UBCOA)

Figure 3. Unbonded concrete overlays

National CP Tech Center

Unbonded Concrete Overlays

For pavements needing improvement to their structure and load carrying capability, major rehabilitation is required. Unbonded concrete overlays provide the additional structure and extend the overall service life of the pavement. Unbonded overlays are popular because they are effective when the existing pavement has a wider range of manageable distress conditions.

The existing pavement may be in the moderately deteriorated to poor condition. Surface distortions are removed by milling and only isolated pre-overlay repairs need to be made. The existing pavement needs only to perform as a stable base and is not counted as a monolithic section with the existing pavement.

In an unbonded concrete overlay, the thickness design does not consider the existing pavement as part of the structural system. See Figure 3 for types of unbonded concrete overlays.

Based on historical data, unbonded concrete overlays are more common than bonded concrete overlays. Data from more than 1,000 concrete overlays from the National Cooperative Highway Research Program

(NCHRP) Synthesis 99, NCHRP Synthesis 204, and the American Concrete Pavement Association (ACPA) National Concrete Overlay Explorer show 75% of unbonded overlays and 25% of bonded overlays have been placed on either concrete or asphalt.

Concrete Overlay Widening

Some state primary and county roadways were originally constructed with Portland cement concrete (PCC) at a narrow width of 18-ft to 20-ft. Over the years, many of these roads have been widened and overlaid with asphalt as a temporary rehabilitation measure. In most cases, these roadway sections are good candidates for a concrete overlay. Figure 4 shows the plan for an unbonded concrete overlay section over a typical, narrow PCC pavement, with the pavement widening as part of the concrete overlay.

When concrete overlays include widening or paved shoulders, special attention should be given to the widening support layer, drainage, tie bar steel, and joint layout. Based on design lessons learned from concrete overlays, long-term performance can be improved.

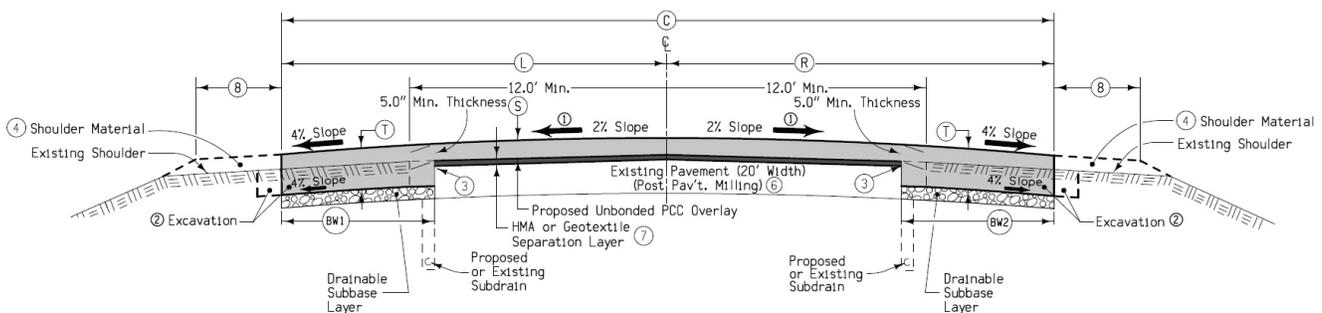


Figure 4. Typical concrete overlay section

Concrete Overlay Design

Several software options may be utilized when designing a concrete overlay. Table 1 lists the typical design and

software parameters as well as the recommended design procedure for each type of concrete overlay.

Table 1. Typical design and software parameters

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 Overlays	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
	Bonded Concrete Overlay of Concrete Pavement	Up to 15	3–6"	Match existing cracks and joints and cut intermediate joints	Fair to Good	Yes	No	No	3, 4, 5
	Bonded Concrete Overlay of Composite Pavement	Up to 15	3–6 in.	1.5 times thickness (in.)	Fair to Good	Yes	No	No	1, 2, 8
	Thin Fibrous Overlays of Asphalt Pavements	Up to 15	2–3 in.	4–6 ft	Fair to Good	Yes	No	No	7
Unbonded Overlays	Unbonded Concrete Overlay of Asphalt Pavement	Up to 100	4–11 in.	Slab < 6 in.—use 1.5 times thickness (in.) Slab ≥ 6 in.—use 2.0 times thickness (in.) Slab > 7 in.—use 15 ft	Deteriorated to Fair	Yes	For slabs > 7 in.	T ≥ 6 in.—use agency standards	3, 4, 5
	Unbonded Concrete Overlay of Concrete Pavement	Up to 100	4–11 in.	Slab < 5 in.—use 6 ft x 6 ft panels Slab 5–7 in.—use 2.0 times thickness (in.) Slab > 7 in.—use 15 ft	Deteriorated to Fair	Yes	For slabs > 7 in.	T ≥ 6 in.—use agency standards	3, 4, 5
	Unbonded Concrete Overlay of Composite Pavement	Up to 100	4–11 in.	Slab < 6 in.—use 1.5 times thickness (in.) Slab ≥ 6 in.—use 2.0 times thickness (in.) Slab > 7 in.—use 15 ft	Deteriorated to Fair	Yes	For slabs > 7 in.	T ≥ 6 in.—use agency standards	3, 4, 5
	Unbonded Short-jointed Concrete Slabs	Up to 100	> 3 in.	4–8 ft	Poor to Fair	Yes	For slabs > 7 in.	For ≥ 3.5 in. slabs at tied concrete shoulders or for T ≥ 6 in.—use agency standards	6

* See additional guidance regarding tie bars for shoulders and widening section

Recommended Design Procedures (far right column):

1. ACPA 2012a.
2. Vandebosche 2015.
3. AASHTO 1993.
4. AASHTO 2008.
5. ACPA 2012b.
6. TC Pavements 2010.
7. Bordelon and Roesler 2011.
8. Roesler et al. 2008.

Reprinted from *Guide to Concrete Overlays* at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf, National CP Tech Center

Section 2. Sample Construction Drawings

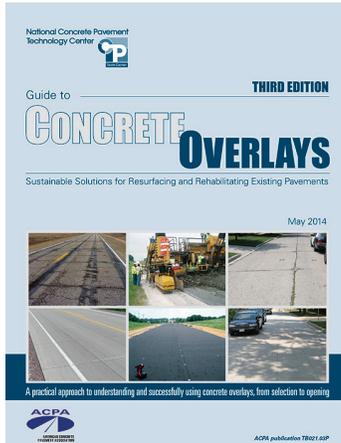


Figure 5. Guide to Concrete Overlays front cover

The *Guide to Concrete Overlays* (available at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf) provided a substantial amount of beneficial and necessary design and construction information (front cover shown in Figure 5).

The sample plan set found in this new supplemental guide (and downloadable as a standalone pdf file online at <http://www.cptechcenter.org/research/research-initiatives/overlays/>) includes commentary for the essential design and construction aspects of a concrete overlay. A set of sample construction plans is an effective tool in the development of an overlay project. This plan set includes sample details and key drawings sheets that are useful with most typical overlay projects.

Keep It Simple

One main item to note is that the concrete overlay construction drawings do not need to be a lengthy set of drawings. They can be simplified by excluding excess pages of plan and profile information. The reproduction of profile sheets is tedious, and these sheets do not need to be included in the drawing set.

Because it is an overlay of the existing pavement, a profile should not be necessary as long as the existing plan and profile drawings are available for reference. However, the pavement design should include a review of the existing profile and cross-section information to determine the effects on raising the grade with an overlay.

When raising the profile grade, special consideration should be given to vertical constraints. These vertical constraints may include the following:

- Overhead clearance
- Barriers and rails
- Safety edge

- Cross-road drainage structures
- Cross slope and superelevation
- Side roads and driveways

A bid item for construction layout typically includes setting the overlay profile; therefore, the profile sheets are not needed in the drawing set. When establishing the profile, the more thorough the profile and cross-section review, the more accurate design overlay quantities will be, and the better yield the contractor will have during construction.

The sample drawings with this guide include details and commentary for both bonded and unbonded concrete overlays. Critical details include the jointing layout and potential widening for both overlay types. The differences between the bonded and unbonded concrete overlay drawings are only in the details. The majority of the drawing sheets are applicable to either type of overlay.

The sample drawing set includes several details that may not be needed on a simpler, more straightforward project. The details within this sample set include pavement widening, turn lanes, jointing details, transitions for bridges, traffic control, construction under traffic, guardrails, miscellaneous quantity tabulations, construction staking information and plans, and profiles.

Description of Drawing Sheets

The following list describes each of the sample drawing sheets for a concrete overlay project. The purpose of the drawings is to provide guidance and detailed information on the essential aspects of the concrete overlay.

The text boxes with red type include commentary for the specific drawing sheet or individual topic. At a minimum, the construction drawings usually require a project title, survey control, quantities, typical sections, miscellaneous details, and profile transition details. Additional optional information may include right-turn details, bridge approach details, shoulder and paved access, guardrails, other tabulations, plan and profile for reference only, and staging, traffic control, staking, and jointing layouts.

Title Sheet

The title sheet provides basic project identification: name, location map (and detour map if necessary),

mileage summary, traffic data, index of sheets, and engineer's certification.

Legend and Survey Control

The legend and survey control sheet provides survey control information necessary to locate and stake out the overlay improvements. For the new concrete overlay, it is recommended to match the alignment stationing for the existing pavement.

Estimated Quantities and Reference Information

This sheet lists the bid item quantities and the estimate reference information. The bid item quantities should match those listed on the form of bid. The estimate reference information includes references to details and tabulations found within the plan set.

The sample plan provided includes separation of quantities into two divisions. This separation may be utilized when there are separate funding sources, such as a roadway that is located in multiple counties or partially located within a municipality and county.

Existing Section and Milling Sheet

The milling sheet includes typical sections for the existing roadway and the pavement milling. The sheet includes commentary on the goals of the milling operation with respect to the type of concrete overlay and amount of pavement remaining after the milling process.

Bonded and Unbonded Typical Cross-Section

This sheet illustrates the typical cross-sections for bonded and unbonded overlays. It includes a tabulation of quantities and the typical cross-section. An important item on this sheet is the separation layer, which is only required for unbonded concrete overlays over concrete.

The separation layer can be a non-woven geotextile layer or a thin (typically 1 in.) hot-mix asphalt (HMA) overlay. The primary benefits of using a non-woven geotextile include the lower cost and the ability for the general contractors to control their own placement operations.

When using a non-woven geotextile, it is very important to provide a drainage outlet. This may be accomplished by terminating the material above a drainable subbase material, daylighting it at the ditch foreslope, or terminating it into a working subdrainage system.

Bonded PCC Overlay Jointing (With and Without Widening)

This sheet includes a typical section with a drainable subbase and treatment of the existing widening unit and edge details, with guidance on the placement of tie bars for a bonded concrete overlay with widening. This sheet also presents a critical detail describing the sawcut width with respect to the underlying concrete pavement for a bonded concrete overlay on concrete.

Unbonded PCC Overlay Jointing (With and Without Widening)

This sheet includes a typical section plan view, joint layout and edge details for the tie bar placement, and details for a separation layer with an unbonded concrete overlay with widening. The widening details include a drainable subbase, treatment for the existing widening unit, and drainage of the separation layer.

If the tie bars are placed at the slab's mid-depth, it is important that the longitudinal saw cuts are limited to thickness divided by 3 ($T/3$) so that the tie bars are not severed. The drawing also covers recommended non-woven geotextile thicknesses based on the concrete overlay thickness.

Miscellaneous Details

This sheet includes utility access details, curb treatments, and examples of separation layer drainage in urban areas.

Profile Transition Details

This sheet includes vertical profile transition details and taper ratios based on vehicle speed. (These details are also found in the *Guide to Concrete Overlays* at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf.)

Right Turn and Bridge Approach Details

This drawing sheet provides details for right-turn lane and bridge approach geometry. This is an optional drawing sheet dependent on the specifics of the project.

Shoulder and Paved Access Details

This drawing sheet includes quantity tabulations for extended paving at side access locations and shoulders. This is an optional drawing sheet based on the specifics of the project.

Guardrail and Paved Shoulder Detail

This drawing sheet includes a sample guardrail barrier and associated details. It is important to use the jurisdictional agency standard for barriers and guardrails instead if one is available. This is an optional drawing sheet based on the specifics of the project.

Quantity Tabulations

This drawing sheet provides several tabulations that refer to construction bid item quantities. This is an optional drawing sheet based on the specifics of the project.

Existing Roadway Plan and Profile for Reference Only

The roadway plan and profile sheets are recommended to be made available to the contractor for reference; however, new plan and profile sheets are not necessary for the construction drawing set. This is an optional drawing sheet based on the specifics of the project.

Staging and Traffic Control Notes

Traffic control and project staging are major components to the success of the project; however, sometimes too much effort goes into developing unnecessary and detailed staging drawings. The most important items needed for the contractor are the critical schedule dates and list of known work or events in the vicinity of the project.

The contractor is typically the best at developing staging plans based on the stated criteria. It is then recommended that the contractor submit a staging and traffic control plan. This is an optional drawing sheet based on the specifics of the project.

Staging Construction Open to Traffic

The advancement of technology including stringless and zero-offset pavers allows more flexibility in how traffic is addressed during paving operations. Various staging diagrams are shown in the *Guide to Concrete Overlays*

(available at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf), which includes a schematic plan to construct a concrete overlay without closing the road to traffic. That drawing sheet is repeated in this set of sample drawings as an image, and the staging diagrams show a concrete overlay for a two-lane roadway with paved shoulders.

The diagrams show the layout of the construction zone and the zone open to traffic. They also discuss the critical steps through the progression of work. The diagrams also offer an option for closing the road to traffic during construction.

This is an optional drawing sheet based on the specifics of the project, and other staging schematic plans appear in the *Guide to Concrete Overlays* (available at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf).

Staking Layout

This sheet shows a typical layout for staking of the overlay including stationing, radius points, paved shoulders, and special shaping areas. This is an optional drawing sheet based on the specifics of the project.

Jointing Layout

It is recommended to provide the joint layout at intersections to give guidance to the contractor. With the jointing layout, it is noted that field adjustments to joint types and locations are allowed and are often necessary. With careful consideration, the field changes can be made successfully. This is an optional drawing sheet based on the specifics of the project.

Concrete overlays can be effectively constructed while roadways are open to traffic. However, there are increased traffic control costs associated with this type of construction and these costs need to be considered and weighed against the benefits of closing the road during construction.

Based on lessons learned from past projects, consideration should be given to closing sections of the roadway with local detours as an alternative to constructing the overlay under traffic conditions.

Based on the success of previous projects, constructing a concrete overlay while a roadway is open to traffic may be viable for roadways with traffic volumes in the range of 5,000 to 7,000 vehicles per day. For four-lane roadways with higher traffic volumes, two lanes typically are closed for construction while the other two lanes have head-to-head traffic. For roadways with fewer than 5,000 vehicles per day, it may be more feasible to close the road during construction.

TITLE SHEET

Highway Division

PLANS OF PROPOSED IMPROVEMENT ON THE

PROJECT NAME

PCC OVERLAYS AND WIDENING - BONDED & UNBONDED
[Project Description]

REVISIONS

PROJECT IDENTIFICATION NUMBER

PROJECT NUMBER

R.O.W. PROJECT NUMBER

INDEX OF SHEETS

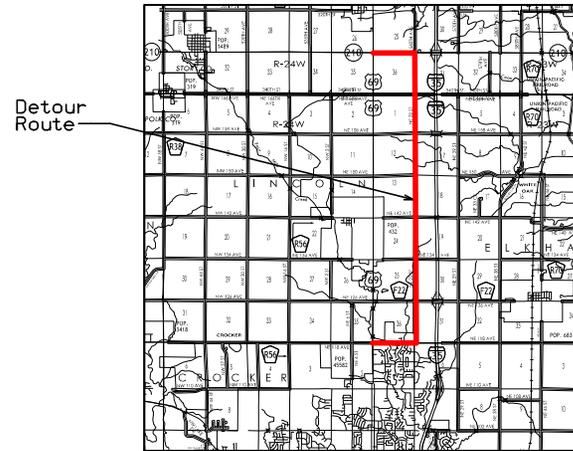
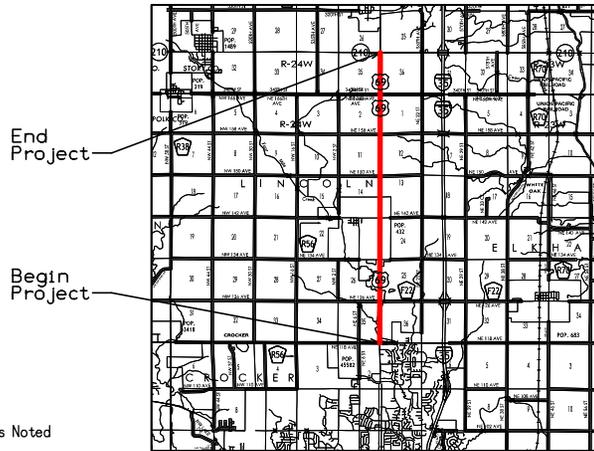
No.	Description
A.1	Title Sheet
A.2	Legend and Survey Control
A.3	Estimated Quantities and Reference Information
B.1	Existing Section and Milling Sheet
B.2	Bonded and Unbonded Typical Cross Section
B.3	Bonded PCC Overlay Jointing (with and without Widening)
B.4	Unbonded PCC Overlay Jointing (with and without Widening)
B.5	Miscellaneous Details
B.6	Profile Transition Details
B.7	Right Turn and Bridge Approach Details
B.8	Shoulder and Paved Access Details
B.9	Guardrail and Paved Shoulder Detail
C.1	Quantity Tabulations
D.1	Existing Roadway Plan and Profile for Reference Only
J.1	Staging and Traffic Control Notes
J.2	Staging Construction Open to Traffic
L.1	Staking Layout
L.2	Jointing Layout

This index is representative of an overlay project (bonded or unbonded) with many details including: staging, traffic control, varying existing cross-sections, turn lanes, transitions for bridges, and construction under traffic. Sheets B.7 to L.2 are optional, depending on the scope of the project.

MILEAGE SUMMARY

Div.	Location	Lin. Ft.	Miles
1			
Total Length			

The information included herein does not represent a specific project, but may be used as an example of what should be included for a PCC bonded or unbonded overlay project.



The location map is helpful to the contractor when planning haul routes, traffic control, and staging.

The detour map is used only if roadway is closed to traffic during construction. If through traffic is allowed during construction, typically traffic control zones are kept to a 0.25 mile maximum length without the use of pilot cars as long as adequate sight distance is available. Construction zones that utilize pilot cars are typically 2.5 to 3 miles in length or no more than 10 minutes wait time per zone.

The title sheet shows general project information including name, description, jurisdiction, index of sheets, mileage summary, traffic, and engineering certification.

DESIGN TRAFFIC DATA			
20_	AADT	_____	V.P.D.
20_	AADT	_____	V.P.D.
	TRUCKS	_____ %	
Total Design ESALs _____			

INDEX OF SEALS		
SHEET NO.	NAME	TYPE

Signature _____	Date _____
Printed or Typed Name _____	
My license renewal date is _____	
Pages or sheets covered by this seal: _____	

LETTING DATE

PCC OVERLAYS - BONDED AND UNBONDED

LEGEND AND SURVEY CONTROL

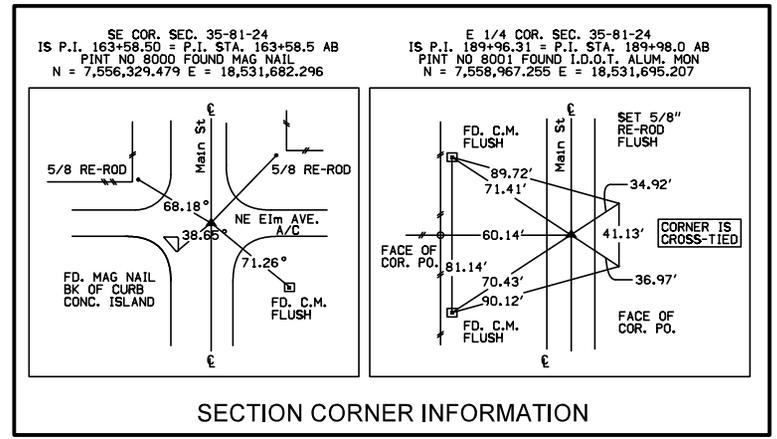
SURVEY SYMBOLS

- DU Centerline Draw or Stream (Up)
- D Centerline Draw or Stream (Down)
- EP Edge of Paved Roads (ML or SR)
- SNP Unpaved Shoulder
- TPD Telephone Pedestal
- SI Sign
- PIP Pipe Culvert
- PRO Profile Shot
- FW Wire Fence
- PLG Location of General Photo
- CU Back of Curb
- TLNR Tree Line Right
- DIK Centerline of Dike or Dam
- RIP Rip-Rap
- IN Storm Sewer Intake
- MIS Miscellaneous
- LUM Luminaire
- TDC Tree Deciduous
- GU Gutter In Front of Curb
- BLD Building or Foundation
- PR Electric Pole
- UB Utility Box
- SL Speed Limit Sign
- MH Utility Access (Manhole)
- SWK Sidewalk
- UE Utility Elevation
- FHD Fire Hydrants
- WV Water Valve
- CON Concrete or A/C Slab
- LIN Miscellaneous Line
- ENP Edge Paved Entrance & Park Lot
- ENT Centerline BL of Entrance
- RET Retaining Walls
- FCL Chain Link and Security Fence
- CUL Culvert
- EB Electrical Box
- ENU Edge Unpaved Entrance & Parking

- SHR Shrub
- SEP Septic Tank
- TEV Evergreen Tree
- TLNL Tree Line Left
- BIN Grain Bin
- BNK Stream Bank
- LP L.P. Tank
- BD Bridge Deck
- FWD Wood Fence
- GV Gas Valve
- WEL Well
- EG Edge of Gravel Road
- GD Guard Rail (Rail and Cable)
- EW Edge of Water
- FLG Flag Poles
- WH Water Hydrant
- HDG Hedge Row
- BB Billboard
- OUT Tile Outlet
- BL Topo Breakline
- GP Guard Post (Less Than 4 Posts)
- UV Underground Utility Vault
- SH Paved Shoulder
- TV Satellite TV Dish
- SNK Sink Hole
- MM Mile Marker Post
- TVP TV Pedestal
- INB Storm Sewer Beehive Intake
- TFR Tree Fruit

UTILITY LEGEND

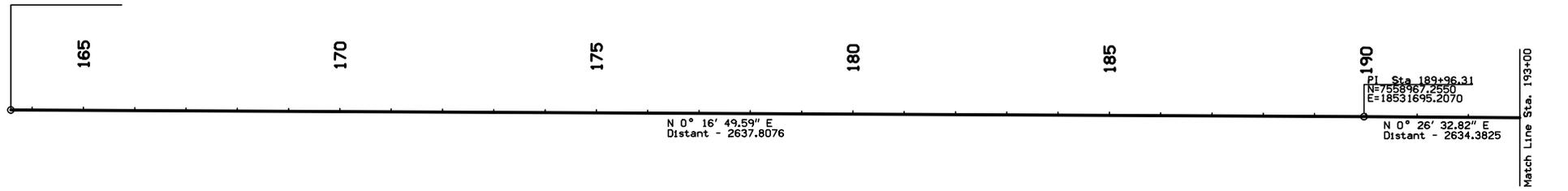
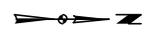
- Power Pole
- E2 - Private Electric
- FO - Fiber Optic
- F02 - Data / Phone
- C - Cable
- G - Natural Gas
- San. - Sanitary Sewer Line
- St.S. - Storm Sewer Line
- W - Domestic Water



AS-BUILT VERTICAL PROFILE					
NAME	LOCATION	STATION	FORWARD GRADE	ELEVATION	CURVE LENGTH

EXISTING REFERENCE POINTS AND BENCHMARKS						
POINT	NORTHING	EASTING	STATION	OFFSET	DESCRIPTION	ELEVATION

POT Sta 163+58.50
N=75563279.4790
E=18531682.2960



This sheet lists the survey symbols, utility legends, and survey control information. The control information is used to establish the alignment for the project.

Section corner information or other control monuments may be necessary to establish alignment.

Benchmark information is used to establish alignment and elevation.

ESTIMATED QUANTITIES AND REFERENCE INFORMATION

ESTIMATED PROJECT QUANTITIES					
ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITIES		
			Division 1	Division 2	TOTAL
1	EMBANKMENT-IN-PLACE	CY	1,721.0	123.0	1,844.0
2	TOPSOIL, FURNISH AND SPREAD	CY	680	0	680
3	TOPSOIL, STRIP, SALVAGE AND SPREAD	CY	363.0	111.0	474.0
4	GRANULAR SHOULDERS	TON	6,902.0	1,690.0	8,592.0
5	PAVED SHOULDER, HOT MIX ASPHALT MIXTURE, 6 IN.	SY	1,423.5		1,423.5
6	SHOULDER CONSTRUCTION, EARTH	STA	10.20	5.10	15.30
7	PATCHES, FULL-DEPTH REPAIR	SY	16.0	32.0	48.0
8	PATCHES BY COUNT (REPAIR)	EACH	2	4	6
9	PAVEMENT MILLING	SY	58,659.0	25,292.0	83,951.0
10	BRIDGE APPROACH	SY	198.9		198.9
11	SEPARATION LAYER HMA*	SY	70,101.00		70,101.00
12	SEPARATION LAYER - GEOTEXTILE*	SY	70,101.00		70,101.00
13	AGGREGATE, COVER - SAND	TON	1.0	0.3	1.3
14	BINDER BITUMEN, CRS-2	GAL	19.2	6.4	25.6
15	PORTLAND CEMENT CONCRETE OVERLAY, FURNISH ONLY	CY	16,954.0	7,283.0	24,237.0
16	PORTLAND CEMENT CONCRETE OVERLAY, PLACEMENT ONLY	SY	87,180.0	37,450.0	124,630.0
17	SURFACING, DRIVEWAY, CRUSHED STONE	TON	26.0		26.0
18	SUBDRAIN, LONGITUDINAL, (SHOULDER) 4 IN. DIA.	LF	27,783.0	9,875.0	37,658.0
19	SUBDRAIN OUTLET	EACH	122	46	168
20	REMOVAL OF STEEL BEAM GUARDRAIL	LF	825.0		825.0
21	STEEL BEAM GUARDRAIL	LF	750		750
22	REMOVAL OF PAVEMENT	SY	12,725.7	404.0	13,129.7
23	SAFETY CLOSURE	EACH	13	6	19
24	FIELD OFFICE	EACH	1		1
25	CONSTRUCTION SURVEY	LS	0.74	0.26	1
26	PAINTED PAVEMENT MARKING, WATERBORNE OR SOLVENT-BASED	STA	1,254.85	494.44	1,749.29
27	PAVEMENT MARKINGS REMOVED	STA	1.70		1.70
28	TRAFFIC CONTROL	LS	0.74	0.26	1
29	FLAGGERS	EACH	20.0		20.0
30	PILOT CARS	EACH	10.0		10.0
31	MOBILIZATION	LS	0.74	0.26	1
32	MOBILIZATION, EROSION CONTROL	EACH	1		1

ESTIMATE REFERENCE INFORMATION	
ITEM NO.	DESCRIPTION
9	PAVEMENT MILLING Profile milling will be required on this project, refer to Typical on sheet B.1 for locations and details. For unbonded or bonded overlays on asphalt or composite pavement. Meet the following requirements for profile milling: 1. Pavement milling equipment shall be equipped with automatic horizontal and vertical controls capable of milling existing pavement at an elevation corresponding to the approved profile grade and cross slope with a tolerance of 0 to -0.5 foot. 2. The contractor will achieve a milled surface for 100% of the pavement surface. The contractor is required to scuff the pavement surface in areas that the mill did not initially touch due to the profile. Profile milling and profile design will consist of the requirements of the Standard Specifications.
10	BRIDGE APPROACH Refer to Typical on sheet B.7.
11*	SEPARATION LAYER HMA
12*	SEPARATION LAYER - GEOTEXTILE
13	AGGREGATE, COVER - SAND - NOTE: CONSIDER GEOTEXTILE IN LIEU OF SAND The item quantity is for 2 applications and is based on 128 sq. yds. at a rate of 10 pounds per square yard per application. Place on existing PCC patches for unbonded overlay.
14	BINDER BITUMEN, CRS-2 - NOTE: CONSIDER GEOTEXTILE IN LIEU OF BINDER The item quantity is for 2 applications and is based on 128 sq. yds. at a rate of 0.10 gallons per square yard per application. Apply on aggregate sand cover over existing PCC patches after milling (for unbonded overlay.)
15	PORTLAND CEMENT CONCRETE OVERLAY, FURNISH ONLY Quantity increase 10% for irregularities. Refer to Typical on sheet B.2. Measurement shall be the quantity shown in the contract documents. The basis of payment will be as indicated in specifications.
16	PORTLAND CEMENT CONCRETE OVERLAY, PLACEMENT ONLY Refer to Typical on sheets B.2, B.3 and the Specifications.
17	SURFACING, DRIVEWAY, CRUSHED STONE
18	SUBDRAIN, LONGITUDINAL, (SHOULDER) 4 IN. DIA.
19	SUBDRAIN OUTLET Refer to Tabulation on sheet C.1. Approximately 2734 cu. yds. of trench material from the subdrain installation shall be disposed of by the contractor as per the Specifications.
20	REMOVAL OF STEEL BEAM GUARDRAIL Refer to Tabulation on sheet B.9.
21	STEEL BEAM GUARDRAIL
22	REMOVAL OF PAVEMENT Refer to Tabulation on sheet C.1. The contractor to dispose of removed pavement as per the standard Specifications.
23	SAFETY CLOSURE Refer to Tabulation on sheet C.1.
24	FIELD OFFICE
25	CONSTRUCTION SURVEY This item does NOT include existing monument or centerline point preservation work which was done previously by others.
26	PAINTED PAVEMENT MARKING
27	PAVEMENT MARKINGS REMOVED Refer to Tabulation on sheet C.1.
28	TRAFFIC CONTROL Refer to the Traffic Control Plan, Tabulation sheet C.1.
29	FLAGGERS - (use when project is constructed open to traffic)
30	PILOT CARS - (use when project is constructed open to traffic)
31	MOBILIZATION
32	MOBILIZATION, EROSION CONTROL

*Choose a separation layer type for PCC unbonded overlay over concrete.

ESTIMATE REFERENCE INFORMATION	
ITEM NO.	DESCRIPTION
1	EMBANKMENT-IN-PLACE Item includes 579 cu. yds for the culvert repairs, 988 cu. yds. for the guardrail grading, and 277 cu. yds. for the right turn lane. Material used for this bid item shall be obtained by the contractor and free of debris. No payment for overhaul will be allowed.
2	TOPSOIL, FURNISH AND SPREAD
3	TOPSOIL, STRIP, SALVAGE AND SPREAD Quantity based on right turn lane work area.
4	GRANULAR SHOULDERS Item includes 1500 tons for shoulders on sheet B.8, 807 tons for the right turn lanes, refer to sheet B.7, Quantity increased 10% for shoulder irregularities.
5	PAVED SHOULDER, HOT MIX ASPHALT MIXTURE, 6 IN. Item includes 1255.5 sq. yds. for shoulders as per sheet B.8
6	SHOULDER CONSTRUCTION, EARTH Item includes 12.9 stations for the right turn lanes, refer to Typical on sheet B.8.
7	PATCHES, FULL-DEPTH REPAIR
8	PATCHES BY COUNT (REPAIR) Refer to Tabulation on sheet C.1.

This sheet lists the estimated quantities for the project. Reference is made to the tabulations, specific details, or other sheets where necessary.

Projects are sometimes separated into divisions to track quantities and payment. For example, Division 1 is funded separately than Division 2 on this sample project.

Some items may be eliminated based on the specifics of the project.

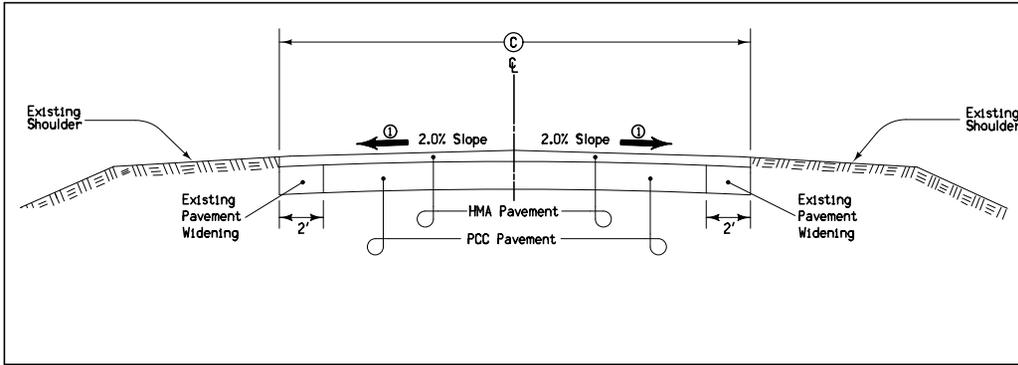
The existing longitudinal subdrains shall remain functional at all times. Any damage to these tile lines or outlets due to the carelessness of the contractor, will be replaced at their expense with no cost to the Owner.

The contractor to note that a profile grade is not being provided and that he/she will be required to cross section the roadway and design a profile grade as stated in the Standard Specifications.

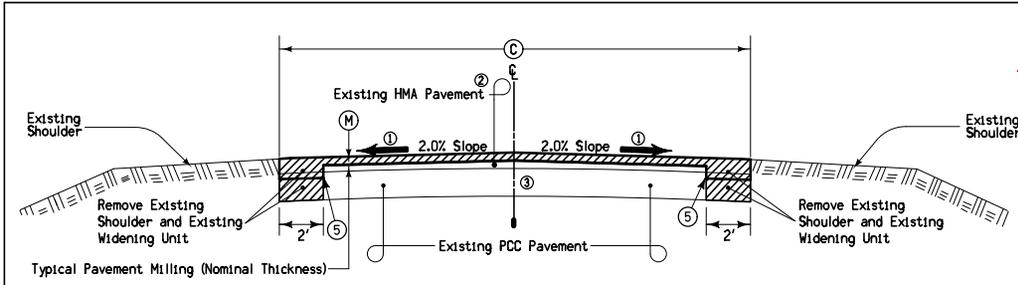
EXISTING SECTION AND MILLING SHEET

Bonded Overlays
 Milling of existing pavement may be necessary to:
 1) achieve the proposed profile,
 2) reduce high spots to ensure minimum overlay thickness,
 3) remove significant surface distortions (2 inches or greater), and
 4) match curb or adjacent structures.
 For bonded overlays, milling to improve bonding is a lower priority than items 2), 3), and 4). A minimum of 4 in. PCC or 3 in. HMA of remaining pavement is recommended after milling.

Unbonded Overlays
 Refer to table 9 of the Guide to Concrete Overlays, Third Edition. If using a 1 in. HMA separation layer and faulting is >3/8 in., grind pavement to remove faulting or increase HMA to 1 1/2 in. thickness. If faulting is ≤ 3/8 in., no action is required. If using a geotextile separation layer, and faulting is > 1/4 in., grind pavement to remove faulting. If faulting is ≤ 1/4 in., no action is required.



EXISTING PAVEMENT CROSS SECTION

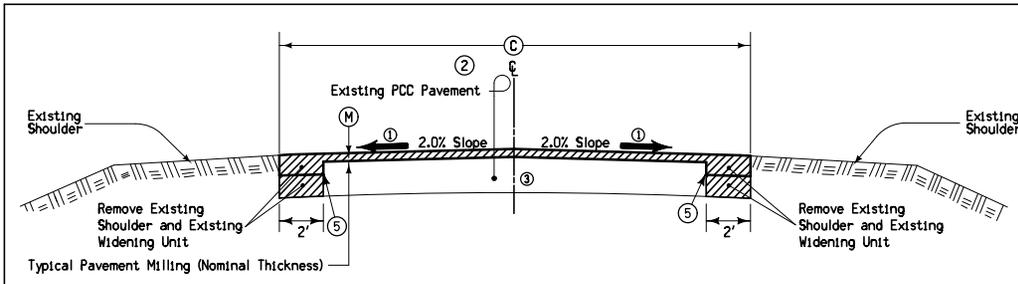


Location		① (M)	② (C)	Pavement Milling	Remarks
Road Identification	Station To Station	Inches	Feet	Sq. Yds.	

- ① Typical section shown may be modified appropriately in areas of super elevated curves or other locations specifically designated by the engineer.
 - * ② After milling, the remaining HMA surface will serve as the separation layer (unbonded overlay over PCC) OR the existing HMA will be completely removed.
 - ③ Refer to sheet C.1 for tabulation of the existing pavement.
 - ④ Allowable milling depth ranges from ___ inch to ___ inches in this area.
 - ⑤ Provide a vertical clean edge similar to milling machine results.
- ▨ Pavement milling or removal.

*Milling option is based on overlay type.

TYPICAL CROSS SECTION
HMA PAVEMENT MILLING



Location		① (M)	② (C)	Pavement Milling	Remarks
Road Identification	Station To Station	Inches	Feet	Sq. Yds.	

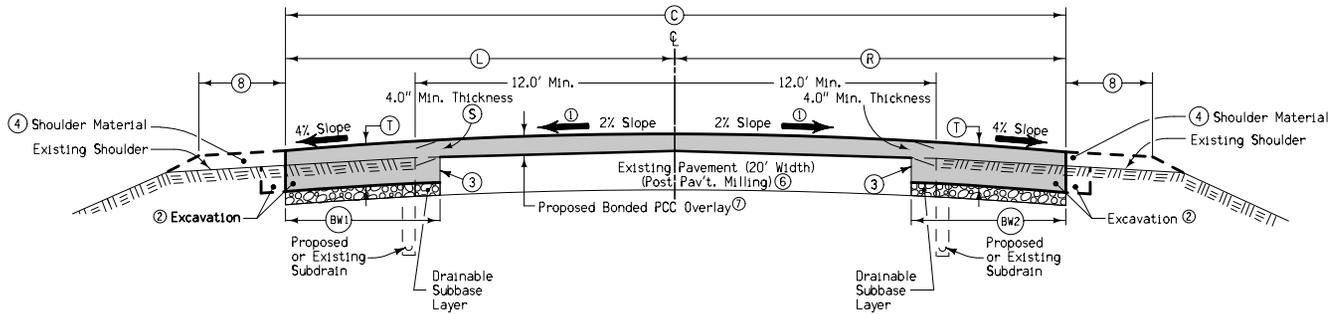
- ① Typical section shown may be modified appropriately in areas of super elevated curves or other locations specifically designated by the engineer.
 - ② Mill existing pavement as necessary to meet proposed profile.
 - ③ Refer to sheet C.1 for tabulation of the existing pavement.
 - ④ Allowable milling depth ranges from ___ inch to ___ inches in this area.
 - ⑤ Provide a vertical clean edge similar to milling machine results.
- ▨ Pavement milling or removal.

TYPICAL CROSS SECTION
PCC PAVEMENT MILLING

This sheet shows the typical cross section for milling of existing pavement as well as a tabulation of milling thickness and areas.

BONDED AND UNBONDED TYPICAL CROSS SECTION

BONDED OVERLAY



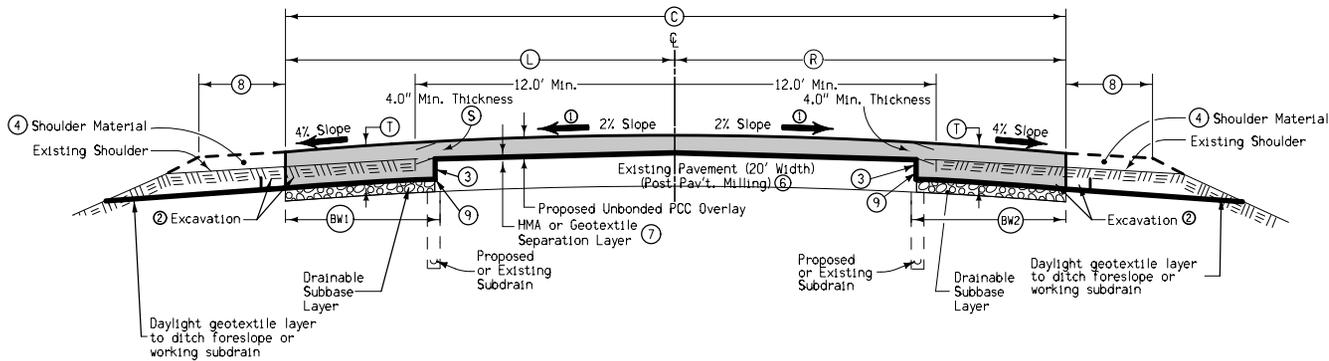
- ① Typical section shown may be modified appropriately in areas of super elevated curves or other locations specifically designated by the engineer. At existing super elevated areas match existing cross slopes and transition rates.
- ② Excavation quantities include trench width (BW) plus 1' x both Lt. & Rt. sides.
- ③ Provide a vertical clean edge similar to milling machine results.
- ④ Shoulder material as specified on sheet B.8.
- ⑤ Refer to jointing and widening details on sheet B.3
- ⑥ Refer to milling detail on sheet B.1.
- ⑦ Milling should be considered to reduce high spots, remove distortions, and match curb or existing structures.
- ⑧ Shoulder width varies by project.

Note: The contractor shall pave proposed shoulders thru all unpaved side road, paved side roads, and entrance intersections. At the existing paved intersections, the existing pavement will be removed.

Location		S	C	L	R	Overlay Quantities (Per Location)				T	BW1	BW2	G	Remarks
						Excavation Cu. Yds.	PCC Overlay Cu. Yds.	PCC Overlay Sq. Yds.						
Road	Station To Station	Inches	Feet	Feet	Feet					Inches	Feet	Feet	Feet	

TYPICAL CROSS SECTION
PCC BONDED OVERLAY WITH BASE WIDENING
(AFTER PAVEMENT MILLING)

UNBONDED OVERLAY



- ① Typical section shown may be modified appropriately in areas of super elevated curves or other locations specifically designated by the engineer. At existing super elevated areas match existing cross slopes and transition rates.
- ② Excavation quantities include trench width (BW) plus 1' x both Lt. & Rt. sides.
- ③ Provide a vertical clean edge similar to milling machine results. Use non-woven vertical geotextile separation layer for drainage if existing pavement is PCC. See sheet B.4.
- ④ Shoulder material as specified on sheet B.8.
- ⑤ Refer to jointing and widening details on sheet B.4.
- ⑥ Refer to milling detail on sheet B.1.
- ⑦ Separation layer may be either 1 inch well-drained asphalt surface mixture or non-woven geotextile. The separation layer must be either daylighted past the edge of the shoulders or connected into a longitudinal subdrain system using drainable subbase layer.
- ⑧ Shoulder width varies by project.
- ⑨ Either drain to working subdrain or daylight fabric

Note: The contractor shall pave proposed shoulders thru all unpaved side road, paved side roads, and entrance intersections. At the existing paved intersections, the existing pavement will be removed.

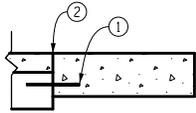
Location		S	C	L	R	Overlay Quantities (Per Location)				T	BW1	BW2	G	Remarks
						Excavation Cu. Yds.	PCC Overlay Cu. Yds.	PCC Overlay Sq. Yds.						
Road	Station To Station	Inches	Feet	Feet	Feet					Inches	Feet	Feet	Feet	

TYPICAL CROSS SECTION
PCC UNBONDED OVERLAY WITH BASE WIDENING
(AFTER PAVEMENT MILLING)

This sheet includes the typical cross sections for PCC bonded and unbonded overlays. A tabulation is given for specific dimensions and quantities.

BONDED PCC OVERLAY JOINTING (WITH AND WITHOUT WIDENING)

Minimum 4 ft. paved shoulder

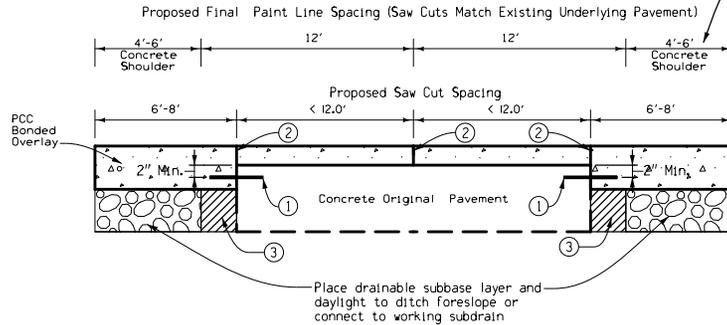


A. Tie widening unit to existing concrete
Cut transverse joints to full depth plus 1/2".
Match existing joint locations.

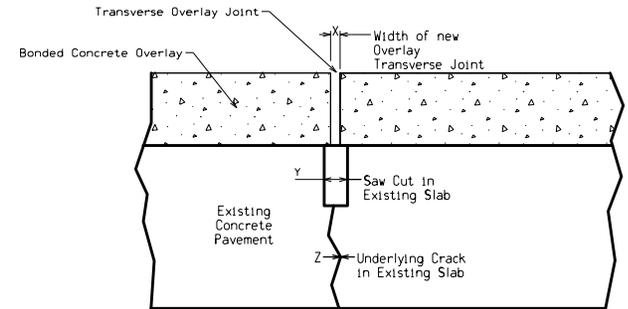
BCOC TIE BAR LOCATION WITH WIDENING

KEYED NOTES:

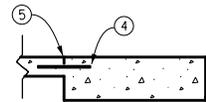
- ① Epoxy coated No. 4 tie bar 36" long at 30" spacing. Drill and epoxy bars into existing concrete
- ② Full depth plus 1/2"
- ③ Existing widening unit:
if Asphalt, remove unit,
if concrete, unit may remain if stable, and 3' wide,
if no widening unit, excavate and place drainable subbase.



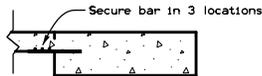
BCOC
BONDED CONCRETE OVERLAY OVER CONCRETE WITH WIDENING



FULL DEPTH SAWCUT
(BCOC) BONDED CONCRETE OVERLAY OVER CONCRETE
(Transverse and longitudinal joint detail in concrete overlay of existing concrete pavement)



A. Tie bar placement with overlay thickness $\geq 5"$

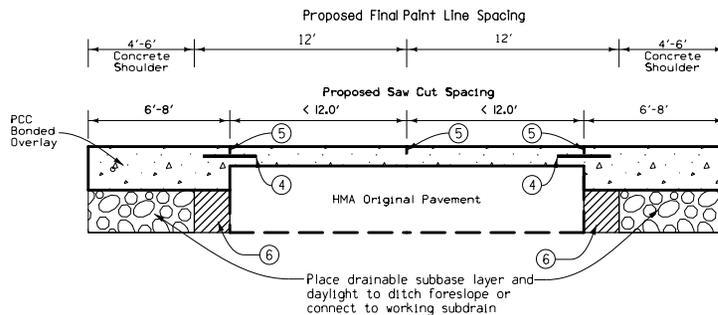


B. For bonded concrete overlays $< 5"$ and in cold weather states with drainable subbase under the paved shoulder/widening unit, secure the tie bar to the asphalt pavement, using a minimum of three staples or epoxy. For concrete overlays $< 5"$ and no drainable subbase, do not use tie bars in the paved shoulders/widening unit.

BCOA TIE BAR LOCATIONS WITH WIDENING

BCOC = Bonded Concrete Overlay over Concrete
BCOA = Bonded Concrete Overlay over Asphalt

This sheet illustrates the jointing layout for PCC bonded overlays and widening units. For bonded overlays on concrete, new joints in the overlay shall align with existing joints. Transverse joints shall be cut to full depth plus 0.5 in. If construction is completed under traffic, a 4 ft paved shoulder is recommended



BCOA
BONDED CONCRETE OVERLAY OVER ASPHALT WITH WIDENING

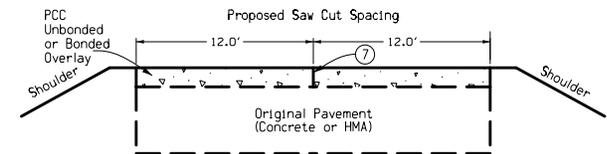
GENERAL NOTES

A. Refer to "Design Lessons Learned" in the document "Guide for the Development of Overlay Construction Documents" for explanation on pavement widening drainage, location of tie bar, location of sawcut, thickened edge, restraint and use of fibers.

KEYED NOTES:

- ④ Consideration shall be given to placement of epoxy coated tie bar at mid-depth. Placement must allow adequate overlay thickness to accommodate maximum sized aggregate under the bar and minimum 2" above the bar. Tie bars are No. 4 bars 36" long @ 30" centers.
- ⑤ T/3 saw cut (do not sever bar)
- ⑥ Existing widening unit:
if Asphalt, remove unit,
if concrete, unit may remain if stable, and 3' wide,
if no widening unit, excavate and place drainable subbase.

Note:
Overlay joint width shall be equal to or greater than crack width of the existing slab. If "Y" is 0.50 in. or greater, the underlying crack width in the existing slab should be measured. If crack "Z" is 0.25 in. or greater, and existing pavement does not have dowel bars, the joints should be evaluated to determine if load transfer rehabilitation is required to eliminate faulting. If there are numerous joints with this condition, the existing pavement may not be a good candidate for a bonded overlay. The existing joints should be filled/sealed to prevent intrusion of mortar during overlay placement. In all cases, "X" must be $Z + 0.125$ in.



BCOC or BCOA

BONDED CONCRETE OVERLAY OVER CONCRETE OR ASPHALT WITHOUT WIDENING

KEYED NOTES

- ⑦ If BCOC, then use full depth sawcut.
If BCOA, then use T/3 sawcut.

UNBONDED PCC OVERLAY JOINTING (WITH AND WITHOUT WIDENING)

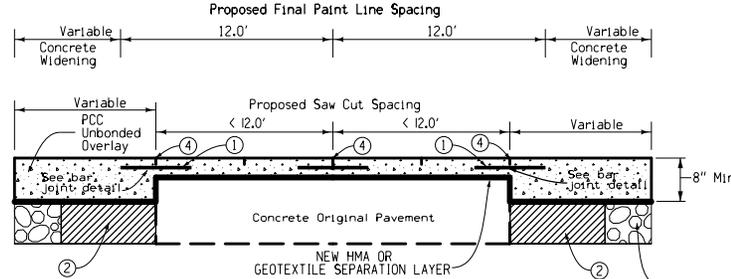
KEYED NOTES:

- ① Consideration shall be given to placement of epoxy coated tie bar at mid-depth. Placement must allow adequate overlay thickness to accommodate maximum sized aggregate under the bar and minimum 2" above the bar. If overlay is $\le 5'$ or placement at mid-depth is not possible, secure tie bar to pavement using a minimum of three staples or epoxy. Tie bars are No. 4 bars 36" long @ 30" centers.
- ② Existing widening unit:
 if Asphalt, remove unit,
 if concrete, unit may remain if stable, and 3' wide,
 if no widening unit, excavate and place drainable subbase.
- ③ Nonwoven geotextile shall either daylight to ditch foreslope or terminate above drainable subbase or connect to working subdrain.
- ④ T/3 (do not sever bar)
- ⑤ For unbonded overlays equal to or less than 6 inches thick, maximum joint spacing in feet is 1.5 times the overlay thickness in inches.

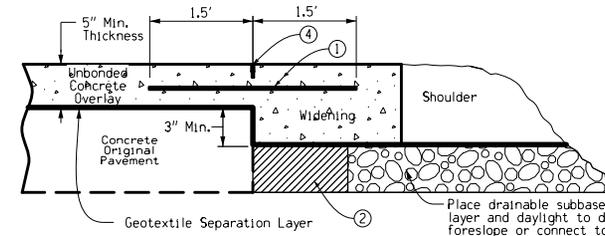
 For unbonded overlays greater than 6 inches thick, maximum joint spacing in feet is 2 times the overlay thickness in inches. Maximum recommended spacing is 15 feet.
- ⑥ An option is to place nonwoven geotextile prior to HMA separation layer

GENERAL NOTES:

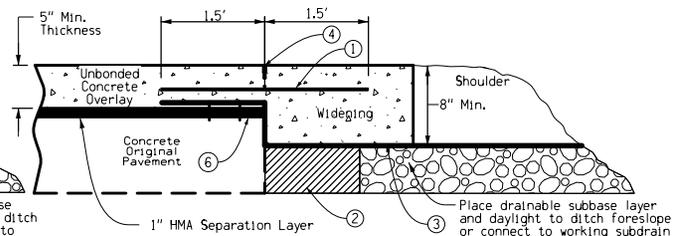
- A. If widening is completed using construction joint:
 a. Fabric must be in good condition and placed as shown.
 b. Tie widening unit with No.4 epoxy coated tie bars. Drill and epoxy or insert during overlay pour.
- B. Before concrete pour, measure and document distance from centerline to outside edge of existing pavement. To establish sawcut between overlay and widening unit, use documented dimensions and locate sawcut using the same measuring method.
- C. Refer to "Design Lessons Learned", in the document "Guide for the Development of Concrete Overlay Construction Documents" for explanation on pavement widening, drainage, location of tie bar, location of sawcut, thickened edge, restraint and use of fibers.
- D. For unbonded concrete overlays without widening, consideration should be given to day-light nonwoven geotextile and HMA separation to ditch foreslope or connect to working subdrain.



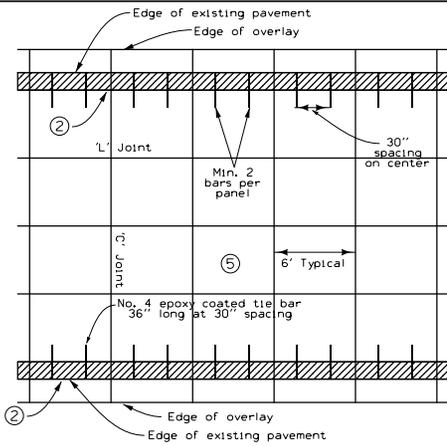
UBCOC
UNBONDED CONCRETE OVERLAY OVER CONCRETE WITH WIDENING



UBCOC
WIDENING DETAIL
NONWOVEN GEOTEXTILE SEPARATION LAYER FOR WIDENING UNIT



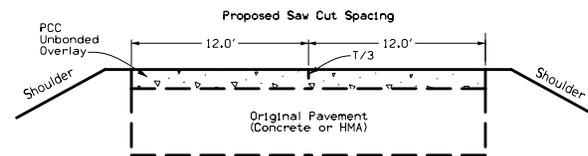
UBCOC
WIDENING DETAIL
HMA SEPARATION LAYER AND NONWOVEN GEOTEXTILE FOR WIDENING UNIT



PLAN VIEW

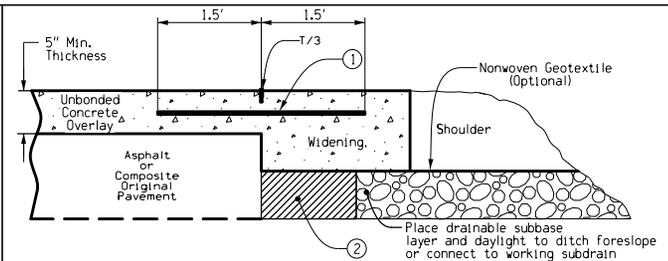
UNBONDED OVERLAY WITH WIDENING - JOINT LAYOUT

Note: Dimensions of panels may change based on project specifics
 L= Longitudinal Joint (T/3)
 T= Saved Transverse Joint (T/3)



UBCOC OR UBCOA
UNBONDED CONCRETE OVERLAY WITHOUT WIDENING

For UBCOC without widening, see detail above for draining separation layer

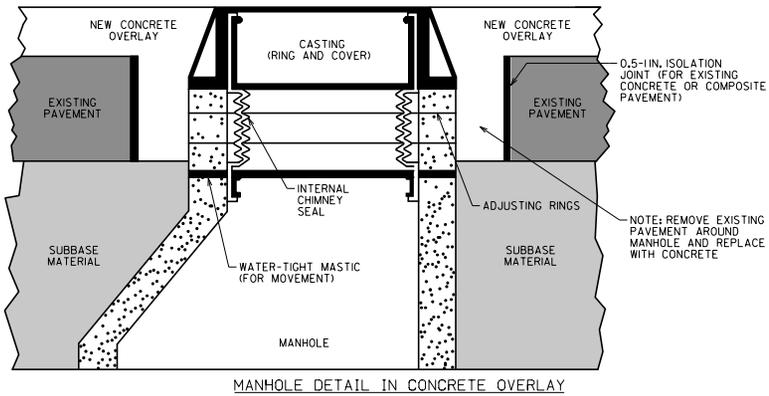


UBCOA
WIDENING DETAIL
UNBONDED CONCRETE OVERLAY OVER ASPHALT OR COMPOSITE WITH WIDENING

UBCOC = Unbonded Concrete Overlay over Concrete
UBCOA = Unbonded Concrete Overlay over Asphalt

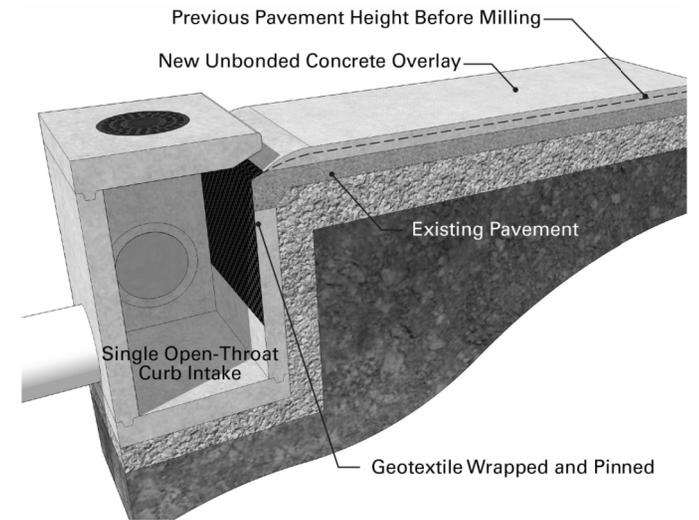
Consider 13.3oz/yd² @ 130 mils, typical weight geotextile, for unbonded overlays ≤ 4 in. thick.
 Consider 14.7oz/yd² @ 170 mils, typical weight geotextile, for unbonded overlays ≥ 5 in. thick.

MISCELLANEOUS DETAILS



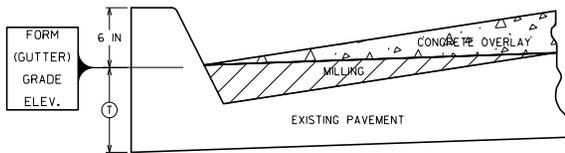
MANHOLE DETAIL IN CONCRETE OVERLAY

This sheet includes miscellaneous details for urban and rural PCC overlays. For unbonded overlays, it is critical to connect the separation layer to an acceptable drainage outlet.

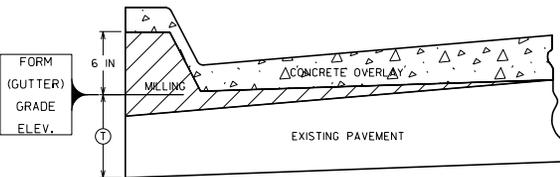


DRAINAGE OF SEPARATION LAYER INTO INTAKE

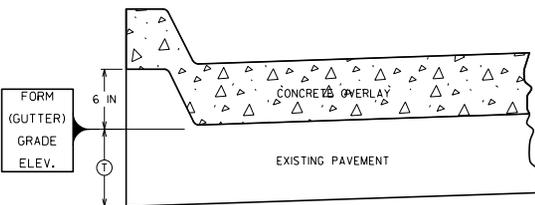
CURB AND GUTTER DETAILS



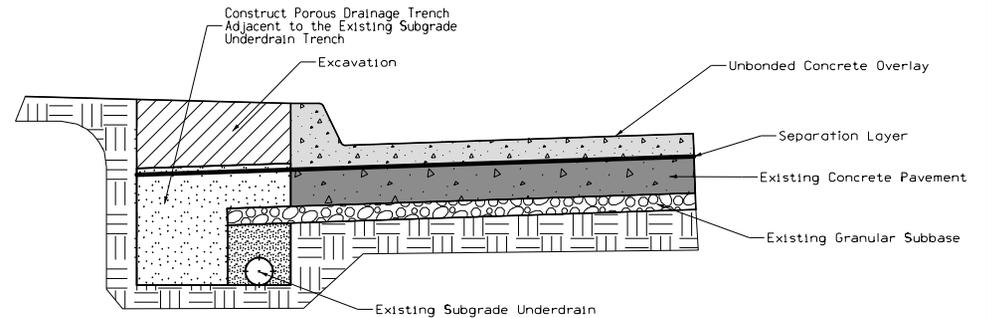
MILLING DETAIL WHEN LEAVING EXISTING CURB IN PLACE



MILLING DETAIL WHEN REMOVING AND REPLACING CURB



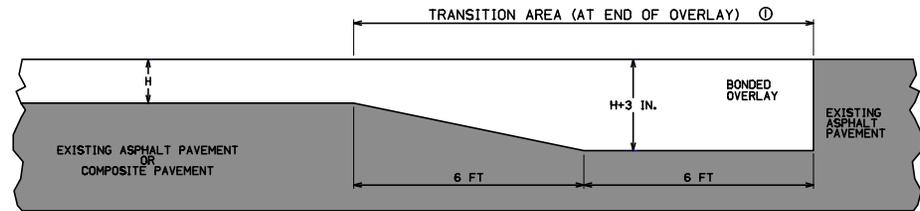
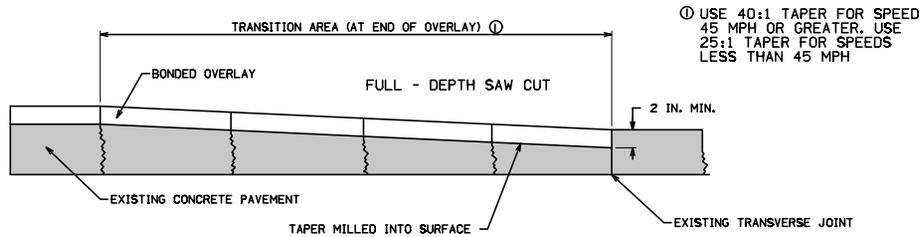
MILLING DETAIL OF CURB OVERLAY



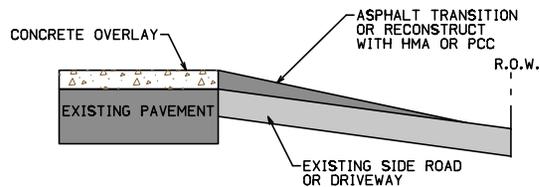
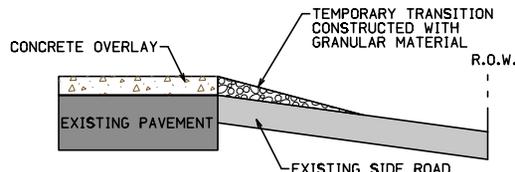
DRAINAGE OF SEPARATION LAYER - UNDERDRAIN SYSTEM
(EXISTING CURB REMOVED AND REPLACED)

ENGLISH	IOWA DOT	DESIGN TEAM	COUNTY	PROJECT NUMBER	SHEET NUMBER	B.5
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PROFILE TRANSITION DETAILS

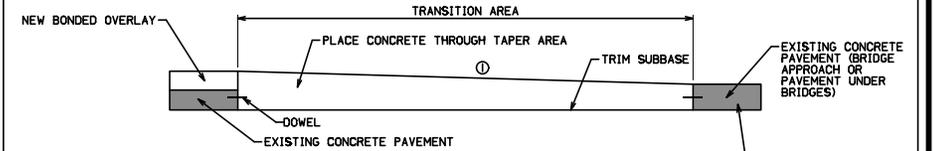


MILL AND FILL PROFILE TRANSITIONS FOR BONDED CONCRETE OVERLAYS ON END TRANSITION

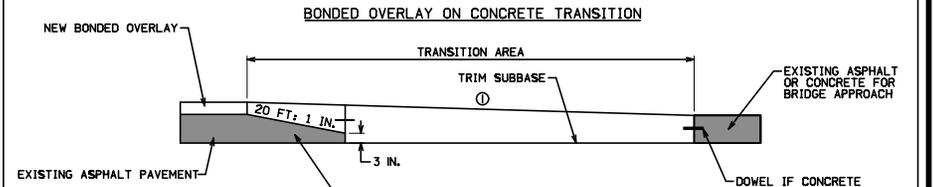


TEMPORARY TRANSITION DETAILS

THE THICKNESS OF THE TRANSITION/RECONSTRUCTION SECTION MUST BE DESIGNED WITH THE UNDERLYING SUPPORT CONDITIONS AND ANTICIPATED TRAFFIC IN MIND. IT HAS NO RELATIONSHIP TO THE OVERLAY THICKNESS NOR THE OVERLAY PLUS EXISTING THICKNESS. USE 40:1 TAPER FOR SPEED 45 MPH OR GREATER. USE 25:1 TAPER FOR SPEEDS LESS THAN 45 MPH.



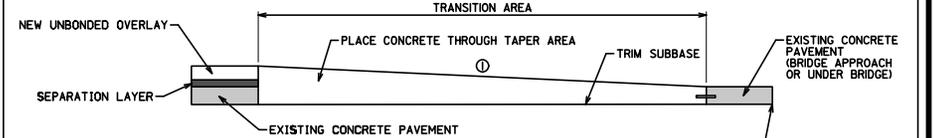
IF THE SECTION IS UNDER BRIDGE, THE EXISTING PAVEMENT MAY REQUIRE RECONSTRUCTION TO INCREASE THE THICKNESS TO PROVIDE FOR EQUAL LOAD-CARRYING CAPABILITIES AS THE OVERLAY SECTION.



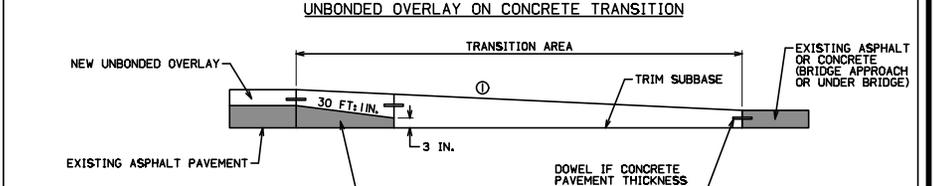
IF LESS THAN 5" THEN TAPER IS NOT NEEDED. DOWEL IF CONCRETE PAVEMENT THICKNESS IS 8 IN. (200 MM) OR GREATER.

BONDED OVERLAY ON ASPHALT TRANSITION

USE 40:1 TAPER FOR SPEED 45 MPH OR GREATER. USE 25:1 TAPER FOR SPEEDS LESS THAN 45 MPH.



IF THE SECTION IS UNDER BRIDGE, THE EXISTING PAVEMENT MAY REQUIRE RECONSTRUCTION TO INCREASE THE THICKNESS TO PROVIDE FOR EQUAL LOAD-CARRYING CAPABILITIES AS THE OVERLAY SECTION.



IF LESS THAN 5" THEN TAPER IS NOT NEEDED. DOWEL IF CONCRETE PAVEMENT THICKNESS IS 8 IN. (200 MM) OR GREATER.

UNBONDED OVERLAY ON ASPHALT TRANSITION

This sheet provides typical profile transition details for PCC bonded and unbonded overlays. The transition length is dependent on the speed limit of the roadway. A common taper for vertical transition is 40:1. The thickness of the transition/reconstruction section must be designed with the underlying support conditions and anticipated traffic in mind

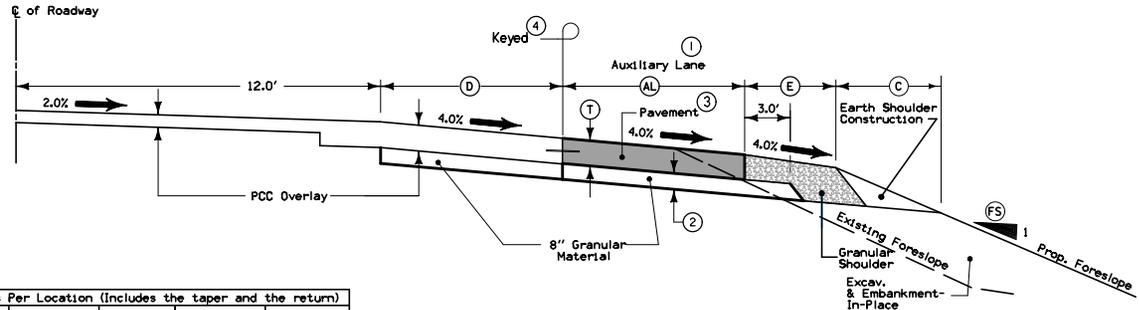
ENGLISH	IOWA DOT	DESIGN TEAM	COUNTY	PROJECT NUMBER	SHEET NUMBER	B.6
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RIGHT TURN AND BRIDGE APPROACH DETAILS

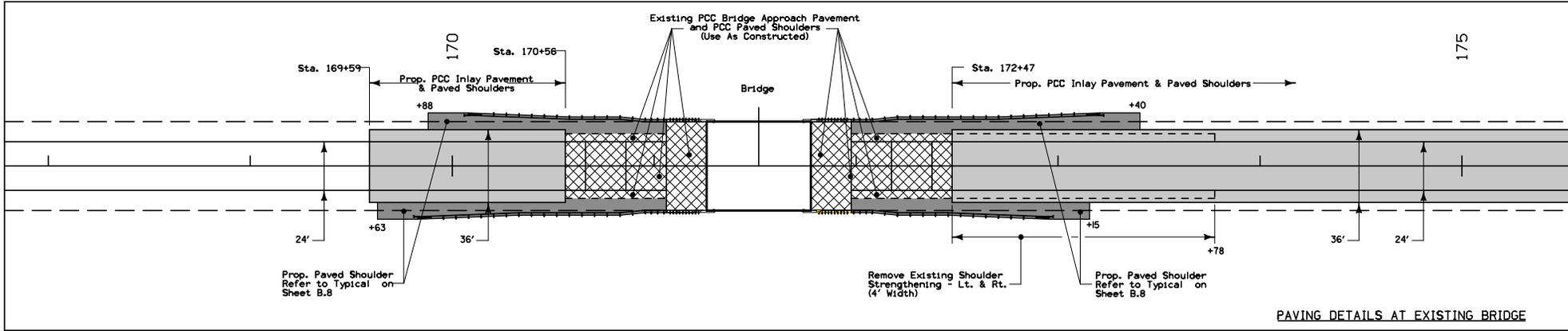
Notes:

- ① Details shall be similar for construction on either side (by stationing) of roadway.
- ② Construct minimum 8" granular material.
- ③ Pavement for auxiliary lane shall be constructed according to requirements specified for through roadway pavement.
- ④ For Joint details see Standard Joint details



LOCATION				Design Quantities Per Location (Includes the taper and the return)											
ROAD IDENTIFICATION	STATION TO STATION	SIDE		(D)	(E)	(T)	(AL)	(C)	(FS)	PCC Pavement Sq. Yds.	Granular Material Cu. Yds.	Embankment In-Place Cu. Yds.	Excavation Cu. Yds.	Earth Shldr. Construction Sta.	Granular Shoulder Tons

**TYPICAL HALF SECTION
PCC RIGHT TURN LANE**
(Adjacent to new PCC Overlay Pavement)



PAVING DETAILS AT EXISTING BRIDGE

This sheet illustrates a typical cross section for a right turn lane and a plan view of a bridge approach.

OPTIONAL RIGHT TURN AND BRIDGE APPROACH DETAILS

QUANTITY TABULATIONS

POINTS OF ACCESS <small>Refer to Cross-Sections</small>																				TABULATION OF SAFETY CLOSURES			
Location		Length of Opening			Pipe Culvert						Driveway Surface Area		Driveway Surfacing Material	Remarks	STATION		CLOSURE TYPE		REMARKS				
Station	Side	Case ①	1 1/2" Dropped Curb	3" Dropped Curb	④	①	②	③	④	Size	Pipe Length	Lt. ②	Rt. ②		Aprons	HMA	PCC	Road Qty.		Hazard Qty.			
		A, B, or C	1 or 2	Lin. Ft.	Lin. Ft.	Ft.	Ft.	Ft.	Ft.	Inches	Lin. Ft.	Lin. Ft.	Lin. Ft.	No.	Sq. Yds.	Sq. Yds.	Tons						
LONGITUDINAL SUBDRAIN SHOULDER AND BACKSLOPE																				TABULATION OF SILT FENCE			
Location		Longitudinal Subdrain						Subdrain Outlet				Remarks	LOCATION		LENGTH	REMARKS							
Line No.	Road or Lane Ident.	Station to Station	Side	Depth	Shoulder		Backslope		Bridge Berm ①		Station		Size	Standard Road Plan and Type			Porous * Backfill	Crushed Stone	STATION TO STATION	SIDE			
				④	Size	Length	Size	Length	Size	Length		(Inches)		(Cu. Yds.)	(Cu. Yds.)								

PAVEMENT MARKINGS																				
* See Typical 9001 for 'A' and 'B' designation																				
② Broken Center Line (Yellow) ⑤ No-Passing Zone Line (Yellow) ⑦ Edge Line Right (White) ⑨ Dotted Line (White) ⑪ Channelizing Line (White) ⑬ Stop Line (White) ⑮ Yellow Curb ⑰ Yield Line (White) ③ Double Center Line (Yellow) ⑥ Broken Lane Line (White) ⑧ Edge Line Left (Yellow) ⑩ Solid Lane Line (White) ⑫ Channelizing Line (Yellow) ⑭ Crosswalk Line (White) ⑯ White Curb ⑱ Double Dotted Line (Yellow)																				
Location		Length (In Stations)																		Remarks
Road Identification	Station to Station	Side	②	③	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮*	⑯*	⑰*	⑱*		
		L R																		

REMOVAL OF PAVEMENT <small>Refer to Tabulation 102-5</small>						* Not a Bid Item
Station to Station	Pavement Type	Area (Sq. Yds.)	Saw Cut # (Lin. Ft.)	Intakes and Utility Accesses (No.)	Remarks	
This tab is used for bridge approaches and vertical transitions.						

TABULATION OF EXISTING PAVEMENT												
No.	Location	Existing Pavement (Type)	Coarse Aggregate			Durability Class	Pavement Thickness (Inches)	Reinforcement (Type)	Detail Typical			
			Gravel	Crushed Stone	Source							

FULL-DEPTH PATCHES																		
Location			Dimension			PCC Patches					Subbase Patches	Subbase Patch w/ 'EF' Joint	Subdrain, Longitudinal, (Patches) 4"	'CD' Joints	'CT' Joints	'EF' Joints	Anchor Lugs Removal	Remarks
Count	Station or Milepost	Lane (L, R or B)	Length	Width	Patch Thickness	With Dowels	Without Dowels	C	R	C								
			FT	FT	IN	RR-4 SY	RR-2 SY	RR-1B SY				RR-26 SY	RR-1 SY	RR-1 or RR-26 LF	No.	No.	RR-1 No.	No.

This sheet provides sample tabulations of typical work items related to a PCC bonded or unbonded overlay. The work item tabulation will vary depending on the scope of the project.

OPTIONAL QUANTITY TABULATIONS

STAGING AND TRAFFIC CONTROL NOTES

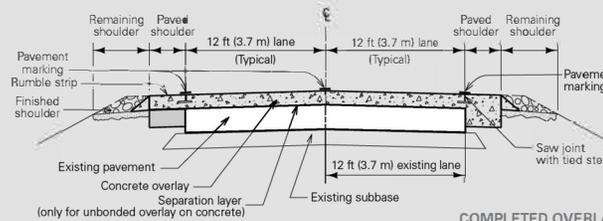
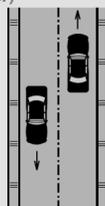
STAGING NOTES	TRAFFIC CONTROL PLAN
<p>① Through traffic on Mainline shall be staged to allow work under traffic and work while detoured. Mainline detour route (refer to map on sheet A.1) shall be signed and maintained by the Jurisdiction Maintenance personnel. The contractor shall provide a 2 week notice to the engineer before any detour use is allowed.</p> <p>② The contractor shall maintain access at all times for residents who live and work along mainline, including school bus traffic. No more than two (2) side roads closed at any time.</p> <p>③ Traffic control on the project shall be in accordance with MUTCD, current edition.</p> <p>④ Unless otherwise directed, the contractor shall take appropriate measurements of the existing pavement marking prior to removing or obliterating them to insure their replacements are positioned in similar locations.</p> <p>⑤ If Mainline is open to traffic, no lane closures will be allowed during the following events:</p>	<p>STAGE 1 TRAFFIC CONTROL A minimum of one traffic lane shall be maintained on Mainline during daytime hours. During night time hours lane closures will not be allowed.</p> <p>CONSTRUCTION Full Depth Patching Pavement Milling</p> <p>STAGE 2 Phase 2A TRAFFIC CONTROL Through traffic on Mainline shall be detoured (refer to Detour #1 map on sheet A.1).</p> <p>CONSTRUCTION Excavation for PCC Widening and Subbase Placement PCC Inlay Pavement / PCC Reconstruction Areas / PCC Overlay Pavement Right turn lane construction PCC / HMA tie - in work at side roads Granular Shoulders Paved Shoulders Guardrail updates Pavement Markings</p> <p>Phase 2B TRAFFIC CONTROL Through traffic on Mainline shall be detoured</p> <p>CONSTRUCTION Excavation for PCC Widening and Subbase Placement PCC Overlay and Widening / PCC Reconstruction Areas Right turn lane construction PCC / HMA tie-in work at side roads Granular Shoulders Paved Shoulders Guardrail updates Pavement Markings</p>
<p>COORDINATED OPERATIONS</p> <p>Other work in progress during the same period of time will include the construction of the projects listed. Coordinate operations with those of other contractors working within the same area.</p>	
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>This sheet is required to list specific staging notes and criteria that the contractor will need to follow during construction. If specific staging or phasing is required, it is recommended to list specific staging criteria instead of drawing detailed staging plans. This gives the contractor flexibility in setting up staging operations and possibly making construction operations more efficient. It is critical that the contractor submits traffic control and staging plans for review prior to construction.</p> </div> <div style="border: 1px solid black; padding: 5px; text-align: center; float: right;"> <p>OPTIONAL STAGING AND TRAFFIC CONTROL</p> </div>	
ENGLISH IOWA DOT DESIGN TEAM	COUNTY PROJECT NUMBER
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STAGING CONSTRUCTION OPEN TO TRAFFIC

COMPLETED OVERLAY (Two-Lane Roadway with Paved Shoulders, Conventional Paver)

Applied to:

- Bonded concrete overlay of concrete pavements
- Bonded concrete overlay of asphalt pavements
- Bonded concrete overlay of composite pavements
- Unbonded concrete overlay of concrete pavements
- Unbonded concrete overlay of asphalt pavements
- Unbonded concrete overlay of composite pavements



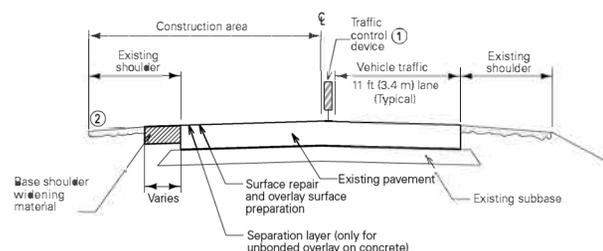
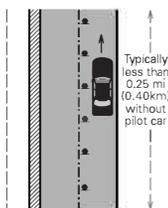
LEGEND

- Stage work area
- Concrete
- Base shoulder widening materials (e.g., cement-treated base, porous concrete, roller compacted concrete (RCC), asphalt, or concrete)
- Granular material

STAGE 1. Repair surface, prepare for overlay, and construct base shoulder widening and separation layer

- Install traffic control and close the left lane. Follow jurisdictional requirements for traffic control. Check with jurisdiction regarding allowable lane closure length. If surface repair and preparation for the overlay are minimal, then slow-moving traffic control may be appropriate. Closing the lane may require additional traffic control (e.g., signals, flaggers, and/or pilot cars).
- Repair the surface as appropriate. Prepare the surface for the overlay (or, in the case of concrete overlay on concrete, the separation layer) as described in the contract document.

- Prepare for shoulder widening by trenching the existing shoulder and trimming to the specified width. The trench should be rolled and compacted as necessary to obtain a firm and stable platform as specified in the contract documents. A continuous progression approach with the shoulder trencher and placement of the base shoulder widening material is encouraged.
- Construct separation layer (only for unbonded overlay on concrete).

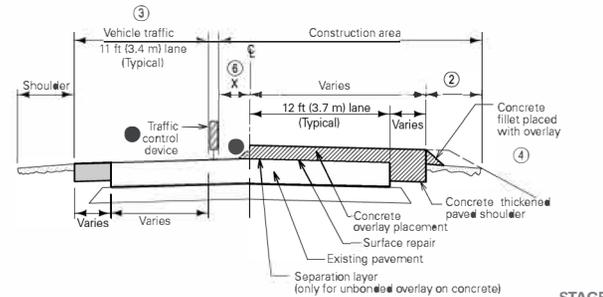
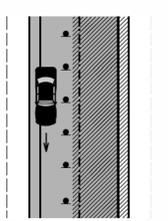


- NOTES:**
- ① Follow jurisdictional requirements for traffic control devices.
 - ② Treat 3 ft (0.9 m) area outside of proposed paved shoulder with calcium chloride. If the existing shoulder outside the proposed paved shoulder is less than 3 ft (0.9 m), it may be necessary to adjust the slipform paver and/or paver control to accommodate the reduced space.
 - ③ Minimum lane width next to the paver may be reduced for short-term, stationary work on low-volume, low-speed roadways when vehicular traffic does not include longer and wider heavy commercial vehicles.
 - ④ If the overlay is opened to traffic in this stage, and final shoulder backfill is delayed, place fillet as shown or (if overlay creates a dropoff greater than jurisdictional allowance) place granular shoulder.
 - ⑤ See centerline fillet illustration and subsequent removal on figure 103.
 - ⑥ For "X" less than 4 ft (1.2 m), adjustments to paver may be necessary to accommodate paver control and paver track.
 - ⑦ The "X" dimension can be reduced to 3 ft (0.9 m) minimum when the right lane is used as paver control.
 - ⑧ Mark edgelines and centerlines per MUTCD (FHWA 2009) section 6F.77 (mark both lanes).
 - ⑨ Construct longitudinal joint.

STAGE 2. Construct right shoulder and concrete overlay

- Shift the traffic control to the left lane and close the right lane to traffic. The length of the closure will depend on the jurisdiction's maximum closure length with pilot car. Traffic controls and traffic control signals will be based on jurisdictional requirements.
- Repair and prepare the surface for the overlay or the separation layer and subsequent overlay as described in the contract documents. Construct separation layer (for unbonded overlay).
- Normal space for the paver stringline is 1–1.50 ft (0.30–0.46 m) and the paver track is a minimum of 2.50–3 ft (0.76–0.91 m). 1 ft (0.3 m) incremental encroachment reduction (up to 2 ft (0.6 m) total) is common through

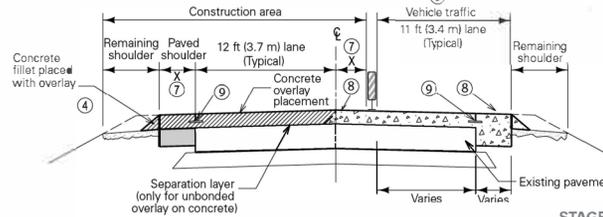
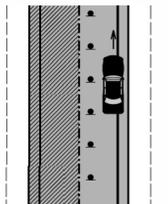
- typical machine adjustment. Speeds should be additionally restricted adjacent to paver when clearance between the paver and vehicle traffic is tight.
- Construct concrete overlay on the existing pavement. Complete right PCC shoulder widening with the overlay. Bull float work shall operate from the outside shoulder only.
- The "X" dimension between the roadway centerline and vertical panel is for the paving machine track and stringline.



STAGE 3. Construct left lane concrete overlay

- Close the opposite lane to traffic and place the concrete overlay according to contract documents, using the same procedures as described in stage 2. Note that stringline may not be necessary for the right edge of the paving when the paved overlay constructed in stage 2 is used as the paver control in this stage. If the right stringline is not used, the "X" dimension could possibly be reduced to 3 ft (0.9 m).

- If the outside edge dropoffs at the shoulder exceeds the jurisdictional allowance for a 1:1 fillet, then construct the granular shoulders in this stage.
- Complete shouldering. Install (mill) rumble strips in the paved shoulders and complete pavement marking and regulatory signing in accordance with contract documents.



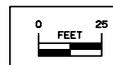
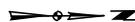
Overlay of Two-Lane Roadway with Paved Shoulders (Conventional Paver)

The sheet provides guidance for staging work when the roadway is open to traffic during construction. This staging diagram, as well as others, are found in Chapter 6 of the *Guide to Concrete Overlays* (Third Edition), May 2014.

OPTIONAL STAGING CONSTRUCTION OPEN TO TRAFFIC

ENGLISH	IOWA DOT	DESIGN TEAM	COUNTY	PROJECT NUMBER	SHEET NUMBER	J.2
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STAKING LAYOUT



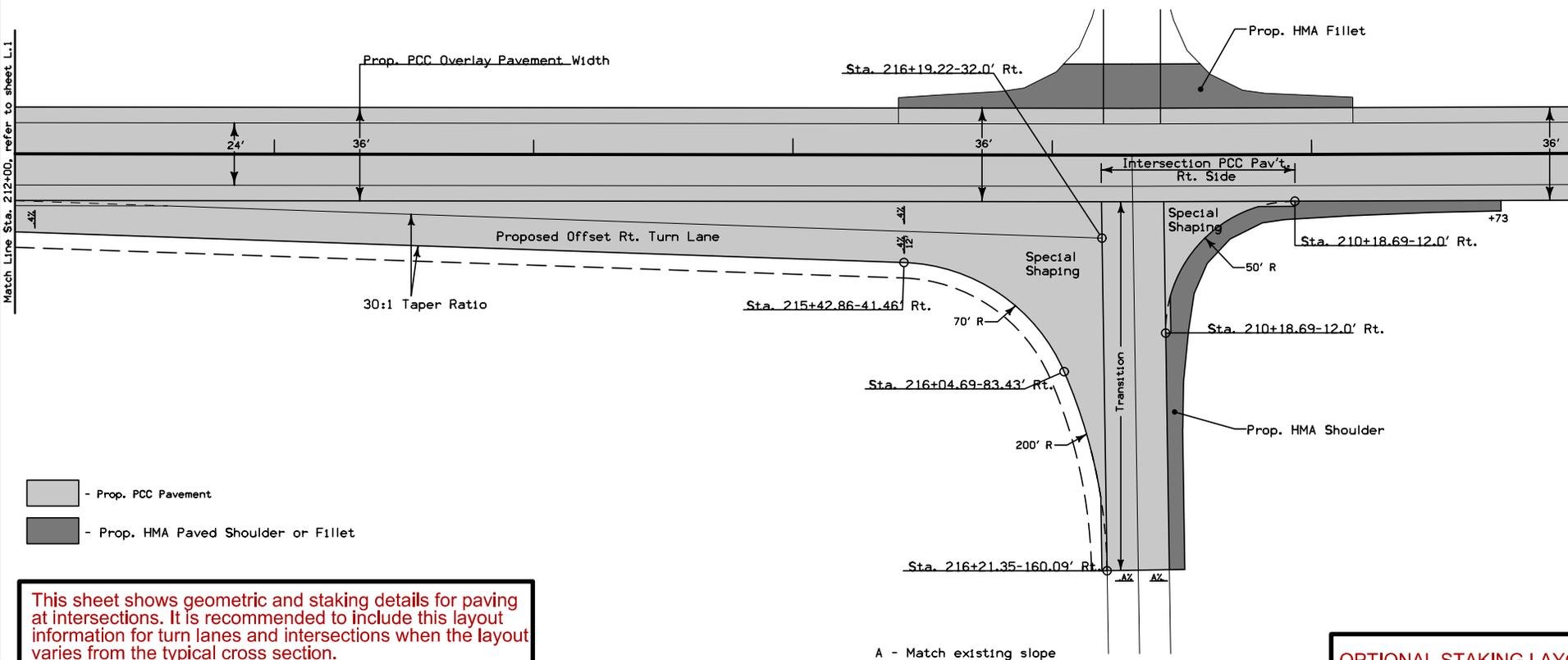
PAVING, GEOMETRIC & STAKING DETAILS

NOTES:

1. For the Rt. Turn Lane pavement quantities and additional information, refer to detail on sheet B.7.
2. For Jointing details, refer to sheet L.2.

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Match Line Sta. 212+00, refer to sheet L.1



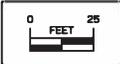
This sheet shows geometric and staking details for paving at intersections. It is recommended to include this layout information for turn lanes and intersections when the layout varies from the typical cross section.

OPTIONAL STAKING LAYOUT

C	ENGLISH	IOWA DOT	DESIGN TEAM	COUNTY	PROJECT NUMBER	SHEET NUMBER	L. 1
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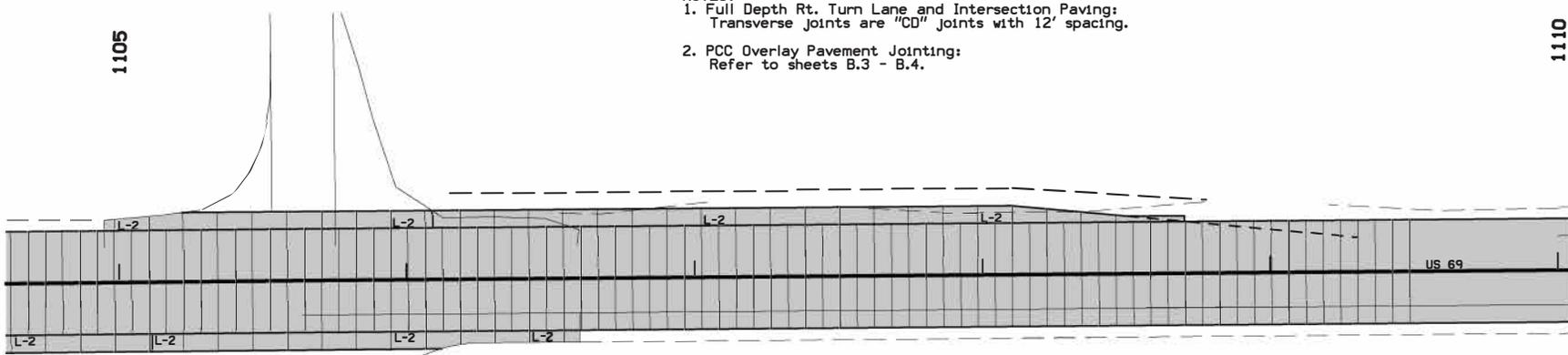
JOINTING LAYOUT



JOINTING DETAILS at Sta. 1105+63

- Prop. PCC Pavement

- NOTES:**
1. Full Depth Rt. Turn Lane and Intersection Paving:
Transverse joints are "CD" joints with 12' spacing.
 2. PCC Overlay Pavement Jointing:
Refer to sheets B.3 - B.4.



This sheet provides a diagram of joint types and locations at intersections or turn lanes when the joint type differs from the typical cross section.

OPTIONAL JOINTING LAYOUT

C	ENGLISH	IOWA DOT	DESIGN TEAM		COUNTY	PROJECT NUMBER	SHEET NUMBER	L.2
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Section 3. Guide Specifications

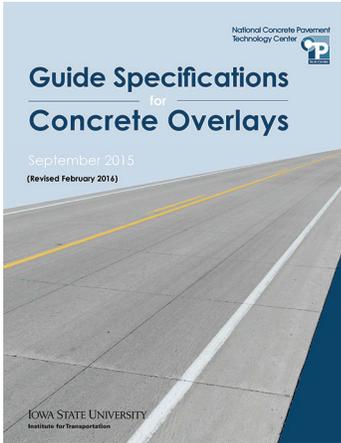


Figure 6. Guide Specifications for Concrete Overlays front cover

The *Guide Specifications for Concrete Overlays* (available at http://www.cptechcenter.org/technical-library/documents/overlay_guide_specifications.pdf) were developed in September 2015, at the request of various paving associations across the country, and re-issued in February 2016 (see front cover in Figure 6.)

The intent of the publication is to provide guidance for the development of project specifications for concrete overlays, and the development of these guide specifications was a result of the Federal Highway Administration (FHWA) pooled fund Next Generation Concrete Pavement Road Map (TPF-5(286)). Five states, including Georgia, Iowa, Michigan, Oklahoma, and Pennsylvania, were instrumental in the development of the guide specifications.

A technical advisory committee (TAC) consisting of six individuals from state departments of transportation (DOTs) and the FHWA was assembled to review the format and content of the guide specifications. The guide specifications should be reviewed and compared to the agency's standard concrete paving specification to develop a specification that relates directly to concrete overlays.

The specifications format is broken into three sections as follows.

Part I. General

This section describes the type of concrete overlay, types of submittals (including mix design, materials, and equipment), quality control, scheduling, delivery, measurement, and payment.

Part II. Products

The products section lists materials and concrete mixes that are allowed for use to complete the project. American Association of State Highway and Transportation Officials (AASHTO) and ASTM International references are used where necessary. A majority of this section references the contract documents, which include the agency's standard materials used in the concrete mix design. The section also includes a table on the recommended geotextile material requirements.

Part III. Execution

The execution sections include the construction requirements for the project. This covers equipment, pavement construction, surface preparation, paving operations, finishing, curing, and jointing.

Section 4. Costs

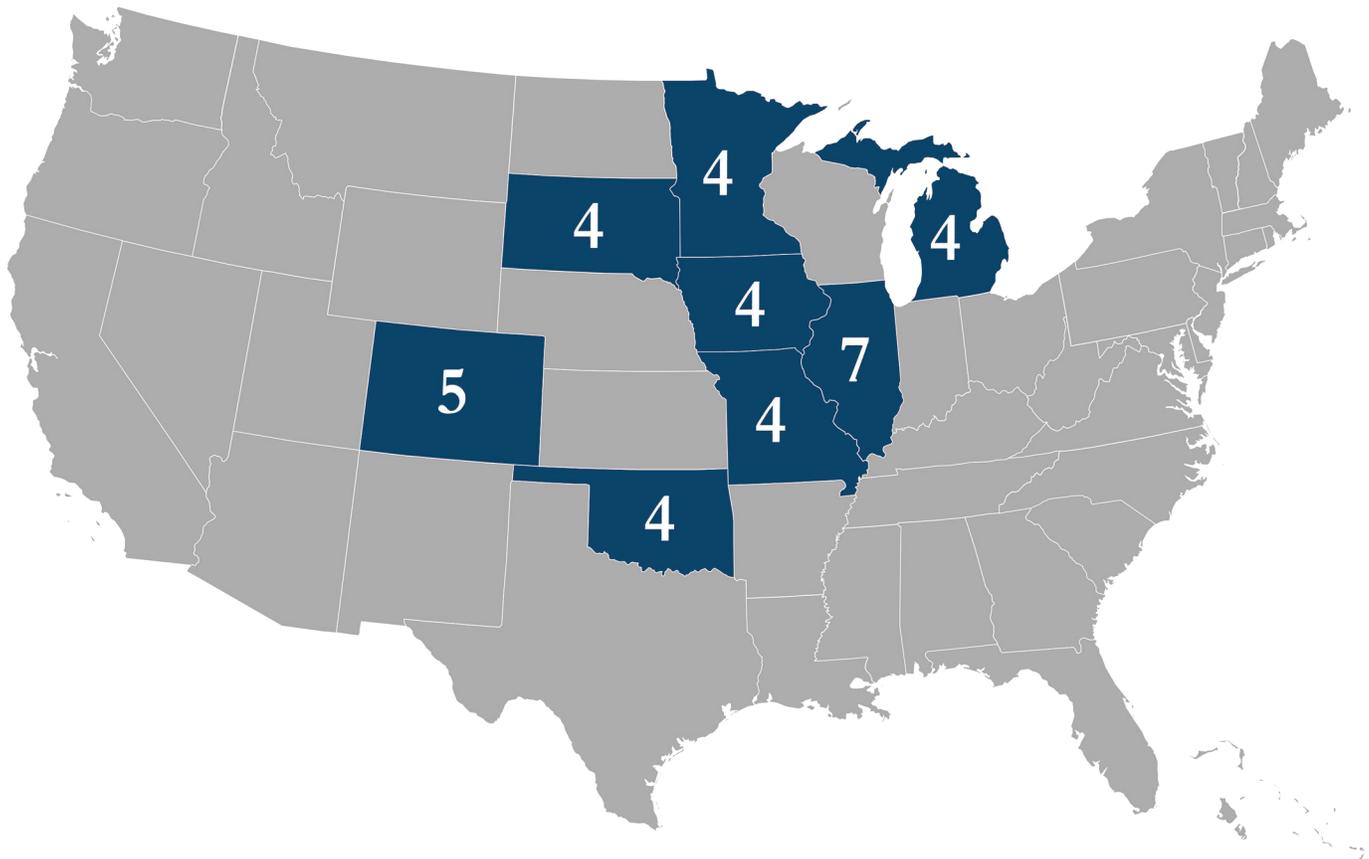
With any rehabilitation project, the solution will nearly always be dependent on the funding available and the associated costs. This section provides information on concrete overlay costs to assist those considering a concrete overlay project.

In June 2010, the National CP Tech Center published a Tech Brief titled *Concrete Overlay Cost: Frequently Asked Questions*, which is available at <http://www.cptechcenter.org/technical-library/documents/cost-FAQ-brief-2010.pdf>. The document covers concrete overlay cost data collected from six Midwestern states.

In 2016, the National CP Tech Center reached out to the concrete paving associations from eight states in the Midwest to identify four concrete overlay projects

per state that were constructed in the past five years. Two bonded and two unbonded overlay projects were requested. Figure 7 shows the map of the associations that were contacted and the number of projects submitted per state.

Once the information was collected and reviewed, a bid cost table was populated in a similar format as the 2010 document. The cost information is a compilation of 36 projects with bid dates ranging from May 2008 through 2016. The overlay costs are inclusive of furnishing concrete, placing the overlay, and all costs associated with finishing, curing, and jointing. The cost data is provided in Table 2 on pages 28 and 29.



National CP Tech Center

Figure 7. States and number of projects included in the cost evaluation

All types of overlays of various thicknesses and project sizes are represented in the sample of overlay costs. Only six of the projects (see Table 3) were bonded overlays.

Table 3. Variation of overlay projects sampled

Overlay Type	Nominal Thickness (in.)	Project Size (yd ²)	Number of Projects
Bonded	3 to 5	15,205–65,057	6
Unbonded	4 to 9	9,898–310,481	30

Of the six bonded overlay projects, only one was a bonded overlay on concrete.

How Much Does a Concrete Overlay Cost?

The overlay cost information was compiled using the bid tabulations received from the individual states. The costs were analyzed using the separate costs for furnishing and placement of the concrete overlay. The total costs were derived by factoring the furnishing and placement costs across the area of the project. These costs included any direct costs related to the concrete overlay such as placement of tie bars, curing, sawing, and sealing. The unit cost (\$/yd²/in.) was derived by dividing this cost by the thickness of the overlay.

The concrete overlay average costs include the following:

- Furnishing concrete
- Placement of the concrete overlay
- Tie bars
- Curing
- Sawing and sealing joints

The concrete overlay average costs do *not* include:

- Pre-overlay repairs
- Separation layer (for unbonded overlays)
- Other non-direct costs including traffic control and mobilization

Figure 8 shows the concrete overlay cost per square yard per inch for the individual states.

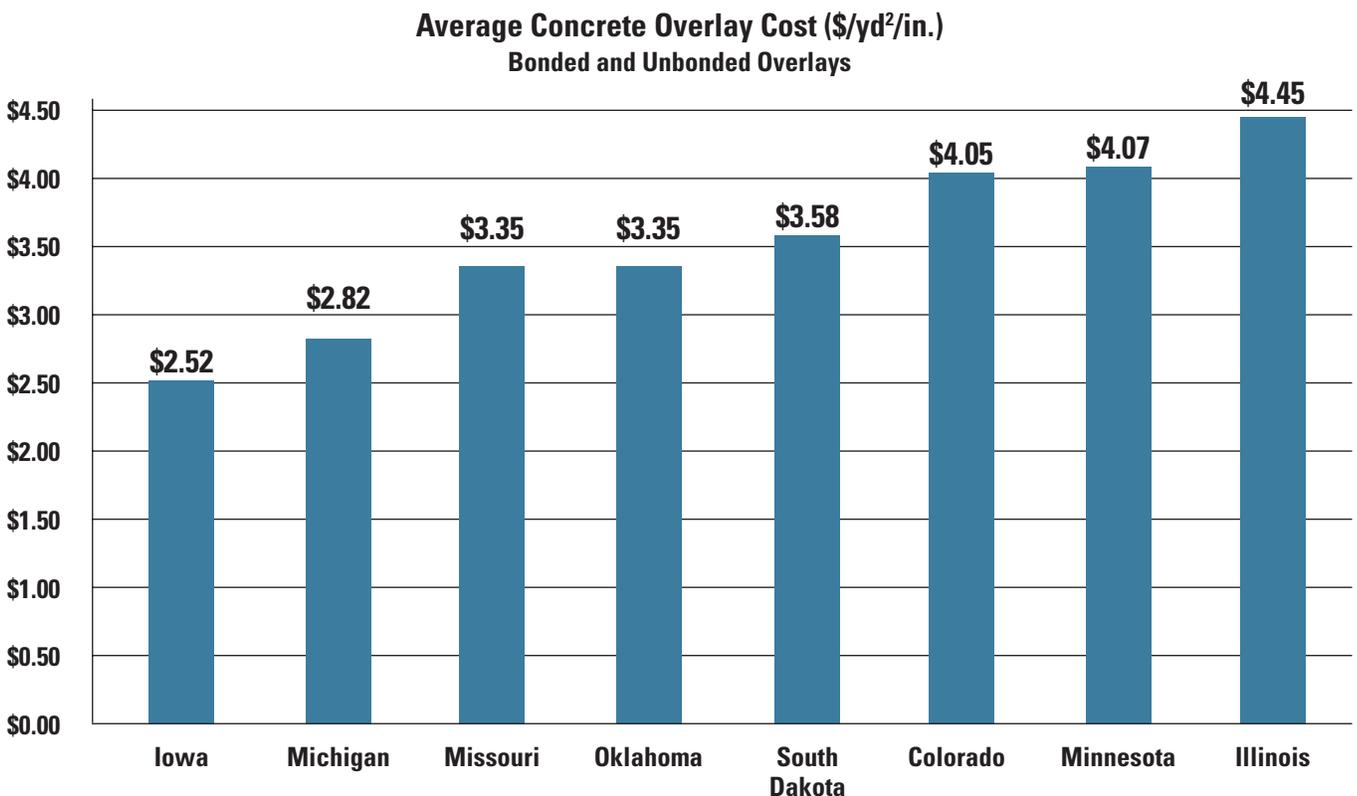


Figure 8. Average concrete overlay cost per square yard per inch by state

Table 2. Cost summary of concrete overlay projects

Project Number	Bid Date	State	County	Bonded on Concrete	Bonded on Asphalt	Unbonded on Concrete	Unbonded on Asphalt	Unbonded on Composite
1.	09035-110397	January 10, 2014	MI	Bay/Arenac		×		
2.	63459-119633-2	January 10, 2014	MI	Oakland		×		
3.	56045-106848-2	May 22, 2013	MI	Midland		×		
4.	63459-116114	June 1, 2012	MI	Oakland				×
5.	J4S2246	May 23, 2008	MO	Jackson/Cass		×		
6.	J6S1961	October 24, 2008	MO	Jefferson/St. Genevieve		×		×
7.	J3P0792B	May 14, 2010	MO	Shelby/Marion				×
8.	J3P2193	February 22, 2013	MO	Marion/Ralls		×		
9.	S.A.P. 013-630-014	February 11, 2014	MN	Chisago			×	
10.	S.A.P. 024-601-017	March 11, 2014	MN	Freeborn			×	
11.	S.A.P. 052-615-024	February 13, 2015	MN	Nicollet			×	
12.	S.A.P. 002-622-034	March 17, 2015	MN	Anoka			×	
13.	72G92-189	March 6, 2015	IL	Sangamon		×		
14.	DE075-13A	April 25, 2014	IL	Macon		×		
15.	99507-070	May 24, 2013	IL	Hamilton			×	
16.	89609-065	August 2, 2013	IL	Henderson			×	
17.	B-00809A	April 17, 2012	IL	Lake			×	
18.	ST-12-05	May 14, 2012	IL	DuPage				×
19.	60N05-069	June 17, 2011	IL	Will		×		
20.	STP-S-C050(99)--5E-50	January 22, 2014	IA	Jasper		×		
21.	STP-S-C060(88)--5E-60	December 17, 2013	IA	Lyon		×		
22.	FM-C098(065)--55-98	February 18, 2014	IA	Worth		×	×	
23.	STP-S-C084(147)--5E-84	March 17, 2015	IA	Sioux		×		
24.	Route 1B	January 2015	SD	Union		×		
25.	NH 0014(176)338	March 21, 2012	SD	Beadle		×		
26.	NH 0212(159)367	September 4, 2013	SD	Codington			×	
27.	IM 0903(91)174	September 3, 2014	SD	Jones/Jackson		×		
28.	CIRB-137C(075)RB	May 16, 2013	OK	Kingfisher		×		
29.	NHPP1Y-0044-1(098)000	October 17, 2013	OK	Cotton			×	
30.	STP-STIM(421)AG	February 2010	OK	Canadian/Cornwell	×			
31.	IMY-0040-6(369)265	October 21, 2010	OK	McIntosh		×		
32.	IM 0701-211	May 10, 2012	CO	Mesa		×		
33.	STA 0142-051	May 7, 2015	CO	Larimer & Weld			×	
34.	IM 0705-079	February 19, 2015	CO	Kit Carson				×
35.	IM 0705-079	February 19, 2015	CO	Kit Carson				×
36.	STA 0132-019	December 17, 2015	CO	Moffat		×		
TOTAL				1	5	15	13	6

Table 2. Cost summary of concrete overlay projects

Project Number	Calculated Overlay Thickness (in.)	Joint Spacing (ft)	Cubic Yards (yd ³)	Furnish Materials		Placement	Furnish + Placement	Separation Layer			Total Cost (\$/yd ² /in.)	Total Cost (\$)
				Furnish Concrete (\$/yd ²)	Square Yards (yd ²)	Square Yards (yd ²)	Total Cost (\$/yd ²)	Asphalt	Geotextile Fabric	Geotextile Fabric Cost (\$/yd ²)		
1.	6 in.	12 ft	33,057	\$7.80	150,051	\$10.83	\$18.63	×			\$3.11	\$2,795,450
2.	5 in.	12 ft	4,700	\$7.80	32,830	\$11.54	\$19.34	×			\$3.87	\$634,932
3.	6 in.	12 ft	57,770	\$12.06	310,481	\$3.50	\$15.56	×			\$2.59	\$4,831,084
4.	5 in.	12 ft	3,000	\$10.20	31,583	\$2.65	\$12.85	×			\$2.57	\$405,838
5.	5 in.	6 ft	6,558	\$15.16	44,973	\$7.50	\$22.66		×		\$4.53	\$1,019,088
6.	5 in.	6.5 ft	30,600	—	200,287	\$5.00	\$16.45		×	\$3.50	\$3.29	\$3,294,726
7.	5 in.	6 ft	15,893	\$10.17	101,812	\$4.36	\$14.53				\$2.91	\$1,479,328
8.	5 in.	6 ft	18,088	\$10.06	113,246	\$6.90	\$16.96		×		\$3.39	\$1,920,652
9.	6 in.	6.5 ft × 12 ft	11,625	\$18.00	69,750	\$7.40	\$25.40	×			\$4.23	\$1,771,650
10.	5 in.	6 ft × 6 ft	13,180	\$11.30	86,248	\$4.30	\$15.60	×			\$3.12	\$1,345,469
11.	5 in.	6 ft × 6 ft	13,596	\$13.69	96,284	\$6.75	\$20.44	×			\$4.09	\$1,968,045
12.	6 in.	6 ft × 6 ft	5,020	\$23.34	30,061	\$13.67	\$37.01	×			\$6.17	\$1,112,558
	8 in.	6 ft 6 ft	2,260	\$23.34	10,178	\$12.76	\$36.10	×			\$4.51	\$367,426
13.	6 in.	6 ft	25,347	—	152,080	\$26.81	\$26.81		×	\$4.45	\$4.47	\$4,077,265
14.	3 in.	4 ft	1,538	\$11.16	15,205	\$17.10	\$28.26	×			\$9.42	\$429,693
15.	4 in.	4 ft	4,622	\$11.59	40,530	\$3.62	\$15.21	×			\$3.80	\$616,461
16.	5 in.	6 ft	7,357	\$18.42	52,674	\$5.27	\$23.69	×			\$4.74	\$1,247,847
17.	5 in.	4 ft	192	—	1,384	\$30.00	\$30.00				\$6.00	\$41,520
	6 in.	6 ft	1,685	—	10,105	\$30.00	\$30.00				\$5.00	\$303,150
18.	5 in.	4 ft	1,376	—	9,898	\$25.36	\$25.36		×	\$2.50	\$5.07	\$251,013
19.	4 in.	4 ft	13,789	—	125,350	\$15.25	\$15.25				\$3.81	\$1,911,588
20.	7 in.	12 ft	24,256	\$13.19	125,031	\$4.00	\$17.19		×	\$2.40	\$2.46	\$2,149,282
21.	5 in.	6 ft	10,520	\$9.95	65,057	\$3.00	\$12.95				\$2.59	\$842,488
22.	5 in.	6 ft	10,156	\$10.19	65,288	\$2.80	\$12.99		×	\$1.91	\$2.60	\$848,091
23.	6 in.	11 ft × 11 ft	11,149	\$12.47	63,482	\$2.59	\$15.06		×	\$1.64	\$2.51	\$956,039
24.	5 in.	5 ft	6,657	\$16.53	40,272	\$6.15	\$22.68		×	\$2.40	\$4.54	\$913,369
25.	5 in.	5 ft	14,804	\$13.87	100,322	\$2.80	\$16.67		×	\$2.81	\$3.33	\$1,672,368
26.	9 in.	15 ft	57,000	\$28.42	226,450	—	\$28.42				\$3.16	—
27.	8 in.	15 ft	45,100	\$26.88	181,214	\$5.25	\$32.13		×	\$2.91	\$4.02	\$5,822,406
28.	5 in.	6 ft	8,556	\$16.72	54,077	\$4.25	\$20.97				\$4.19	\$1,133,995
29.	9 in.	15 ft	41,348	\$21.72	61,257	\$6.00	\$27.72				\$3.08	\$1,698,044
30.	3 in.	15 ft	1,897	\$10.00	22,764	\$8.00	\$18.00	×			\$6.00	\$409,752
31.	8 in.	15 ft	86,271	\$18.76	159,055	\$3.48	\$22.24	×			\$2.78	\$3,537,383
32.	6 in.	6 ft	36,827	\$63.01	203,967	\$7.87	\$19.25				\$3.21	\$3,926,365
33.	8 in.	15 ft	—	—	233,965	—	\$39.00				\$4.88	\$9,124,635
34.	8 in.	15 ft	—	—	245,162	—	\$31.55	×			\$3.94	\$7,734,861
35.	8 in.	15 ft	—	—	179,500	—	\$31.55	×			\$3.94	\$5,663,225
36.	6 in.	6 ft	—	—	146,347	—	\$25.29				\$4.22	\$3,701,116

When these costs were compared to the 2010 study, it was found that the average costs across the 36 projects have increased slightly from \$2.99/yd²/in. to \$3.45/yd²/in. Figure 9 illustrates the average cost of the concrete overlays per square yard sorted by individual thickness. Figure 10 shows the average cost for concrete overlays per mile using a fixed cost of \$3.45/yd²/in. based on a 24 ft wide pavement width.

The costs include an additional \$3.00 per square yard for the separation layer on unbonded overlays of 7 in. and greater. Costs associated with the non-woven geotextile separation layer were listed separately in Table 2. The simple average cost for the non-woven geotextile fabric over nine projects was \$2.72. The weighted average of the geotextile fabric was \$3.03, which includes the size of the overlay project in square yards.

What Variables Will Impact the Cost of Concrete Overlays the Most?

Many variables affect the costs of concrete overlays. The primary factors include the following:

- Cost of concrete materials
- Labor costs
- Fuel costs
- Traffic control
- Project size

The cost of concrete materials will have the greatest effect on the concrete overlay cost. When developing a concrete overlay project, consideration should be given

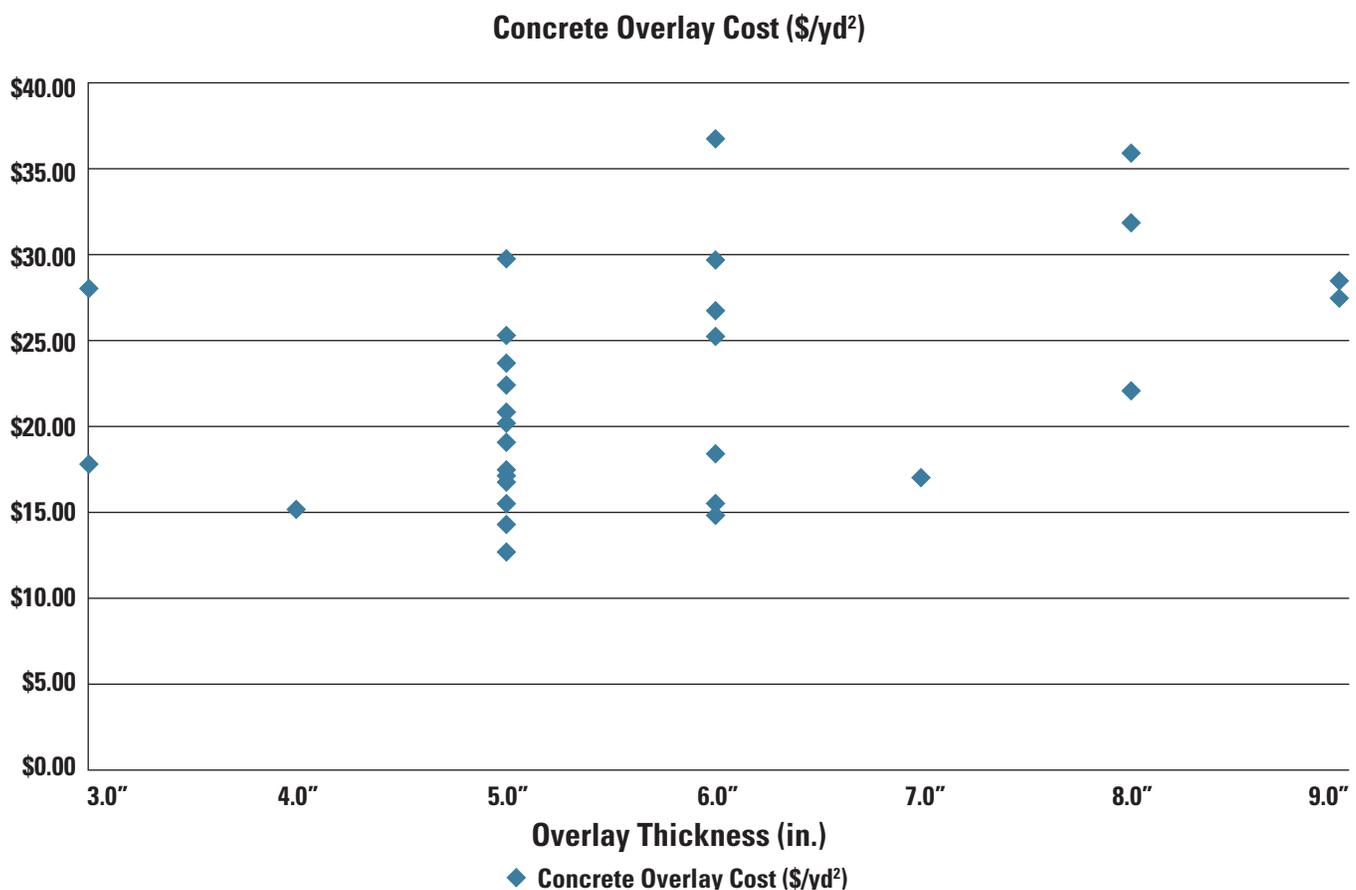


Figure 9. Concrete overlay cost by thickness

Average Concrete Overlay Cost Per Mile (24 ft wide)

Based on fixed cost of \$3.45/yd²/in. and \$3.00/yd² for separation layer for unbonded overlays 7 in. and thicker

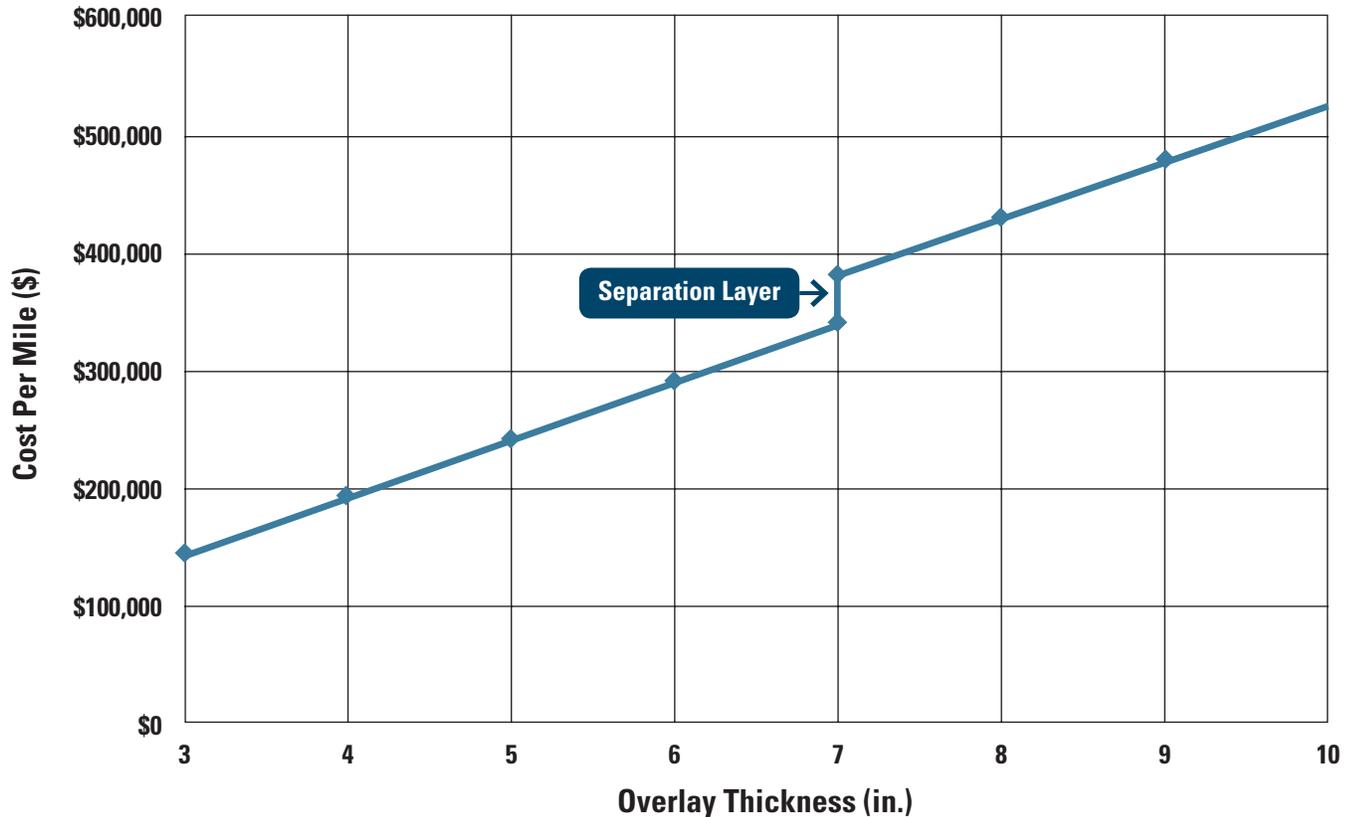


Figure 10. Average cost per mile for concrete overlays

to the amount of pavement that can be constructed using a slip form paver. The increase in handwork adds to the labor effort required on an overlay project.

As stated in the 2010 Tech Brief, labor costs vary from state to state and local wages should be considered when evaluating the overlay costs and comparing them to other states. As with any construction project, fuel costs have an impact on construction cost. The farther that equipment and concrete material need to be hauled to the construction site, the more costly the project.

Careful consideration should be given to traffic control during the construction of the project. As illustrated in Chapter 6 of the *Guide to Concrete Overlays* at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf, technology has advanced

to the point that a majority of concrete overlays can be constructed under traffic. However, the volume of existing traffic on the roadway should be evaluated to ensure that the traffic control approach is feasible for the project. Although concrete overlays can be constructed while open to traffic, there are additional costs for maintaining traffic flow and building in stages versus closing the roadway and placing larger quantities of pavement more quickly.

Finally, project size can affect the cost of the concrete overlay pavement. In Minnesota, concrete overlay costs per square yard per inch are lower (\$3.50/yd²/in.) for overlays over 100,000 yd² as compared to those 30,000 yd² and less (which range from \$4.00 to \$5.50 per yd² per in.).

Section 5. Design Lessons Learned

Based on the performance of concrete overlays over the years, some considerations have been developed to help improve performance on future concrete overlay projects. This section describes in detail the design lessons learned. The details provided in the sample construction drawings have incorporated each of the 11 items in this section.

Heave of Widening Unit (UBCOA)

In cold weather states, it has been shown that the outside paved shoulder/widening can rise in elevation if the subbase is not well drained. Once the pavement has displaced vertically, longitudinal cracking can develop when the shoulder and overlay lack support after the initial vertical displacement during freeze-thaw cycles and under heavy traffic loads. The initial crack is often just off the end of a tie bar that is installed to hold the shoulder unit to the mainline pavement (see Figures 11–13).



Figure 11. Longitudinal cracking along end of tie bar



Figure 12. Improper cross-slope from heave

Recommendation: Support with Drainable Subbase

The way to minimize this risk is to provide a drainable subbase and a drainage outlet under the widening unit/paved shoulder at the time of the overlay. The drainage outlet can be in the form of daylighting the drainable subbase to the foreslope in a rural section or connecting to a subdrain system.

With an unbonded concrete overlay on concrete (UBCOA), a non-woven geotextile fabric separation layer provides the opportunity to wick water from the pavement layers and send it to an outlet beyond the shoulder. This is particularly true when there is a difference in thickness between the overlay section and the widening/paved shoulder (see Figure 14). This will allow the movement of subsurface water away from the pavement structure and minimize risk of widening unit heaving.

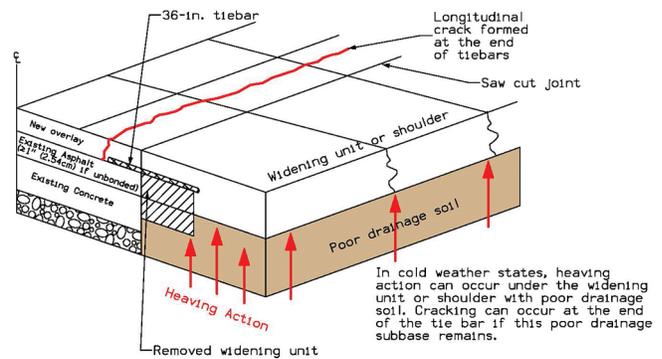


Figure 13. Longitudinal cracking from heaving action

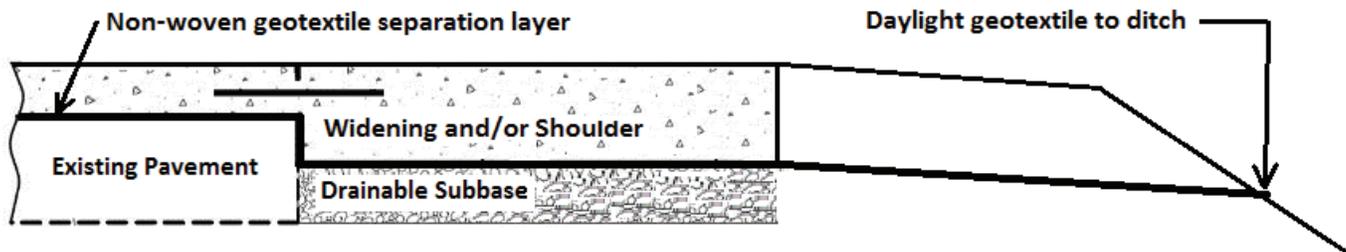


Figure 14. Support widening with drainable subbase

Over-Reinforcing Bottom of Overlay (UBCOA, UBCOC)

For unbonded concrete overlays, some states tie the widening unit to the mainline concrete overlay by securing reinforcing bars to the existing pavement. The bars are installed by epoxy or staples/clamps (see Figure 15).

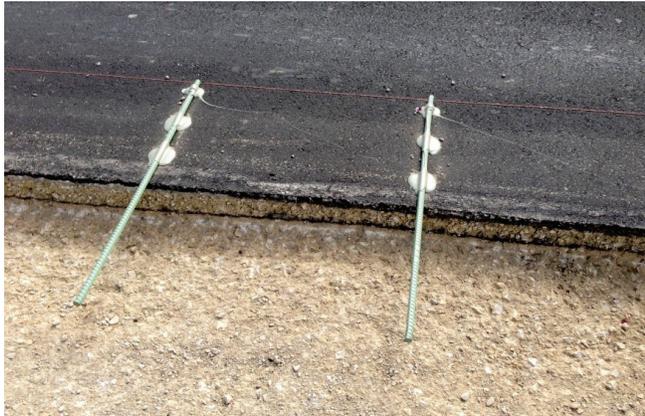


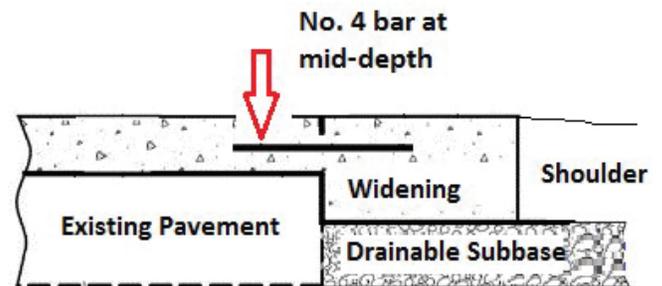
Figure 15. Tie bars affixed to existing pavement using epoxy

In these situations, the overlays can develop longitudinal cracking that is likely due to over-reinforcement of the bottom of the overlay slab where the overlay is in tension. Due to the location of the steel at the bottom of the overlay, the crack may not deploy at the joint of the new overlay because the joint is reinforced. Cracks may instead occur at the end of the tie bar because that may be the weakest section. The way to reduce the potential for cracking away from the saw cut joint is to ensure the cut depth is $T/3$.

Recommendation: Reduce Steel and Relocate Tie Bar

In order to properly reinforce the overlay and widening unit, consideration should be given to placing the tie bar at mid-depth of the overlay (the neutral axis) when possible. This can be accomplished with tie bar inserters if placement tolerances can be maintained. Otherwise, chairs may be necessary.

Quality control checks should be made to confirm the locations of the tie bars behind the paver. The maximum tie bar size should be No. 4 (1/2 in. diameter). The epoxy-coated bars should be 36 in. long and spaced at 30 in. intervals. If the overlay is less than 5 in., tie bars should be secured to the existing pavement as shown in Figure 15. This will ensure tie bars are not damaged when placing the sawcut. (Refer to Figure 18 later in this section for placement of tie bar for overlays equal to or greater than 5 in.)



Note: Secure tie bar to existing pavement if overlay < 5 in.

Figure 16. Tie bar at mid-depth for overlays > 5 in.

Inadequate Thickness at Widening Unit (All Overlay Types)

In rural areas, the paved shoulder/widening unit is subjected to heavy loads such as farm equipment and large wagons. If the widening unit is not thick enough, cracking can result from heavy repetitive loading (see Figure 17).



Figure 17. Excessive shoulder loading

Recommendation: Increase Thickness of Widening Unit

Consider a thicker pavement when constructing a widening unit/shoulder. Recommended minimum thicknesses for widening unit/shoulder are 6 in. for overlays ≤ 4 in. and 7 in. for overlays > 4 in. The thickness of the paved shoulder can also be designed using traffic loading information from the farm equipment (see Figure 18).

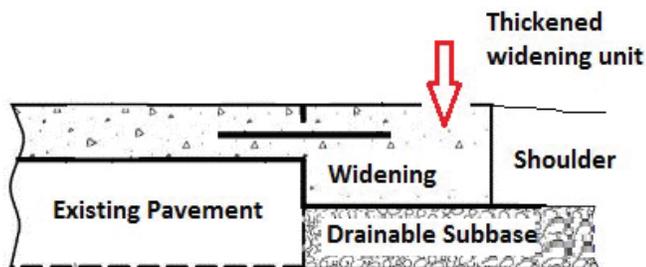


Figure 18. Increase thickness of widening area

Incorrect Location of Longitudinal Sawcut (All Overlay Types)

When paving a widening unit on an overlay, it is critical to locate the sawcut directly above the edge of the existing pavement. If the sawcut is located incorrectly, the crack may not deploy at the sawcut. In particular, if the sawcut is located within the thickened widening unit and, the cut is not at a depth of $T/3$, the crack will deploy at the weakest point in the section; often along the end of the tie bar on inner side of the lane. One reason for the improper sawcut location may be due to variability in the existing pavement width and the method of establishing the sawcut (see Figure 19).

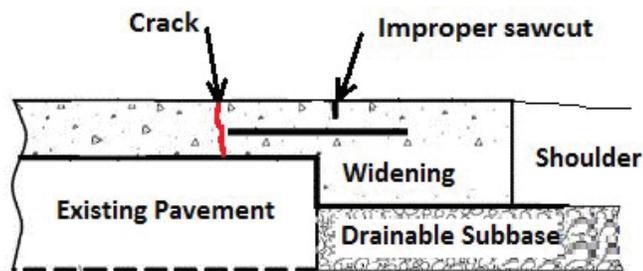


Figure 19. Improper sawcut

Recommendation: Proper Location of Existing Pavement Edge for Sawcut

In order to correctly locate the edge of the existing pavement, measurements should be taken on the existing pavement from the centerline to the existing pavement edge on both sides prior to construction of the overlay. The existing centerline alignment should be verified prior to any marking.

An option to measuring from the centerline before and after the overlay is to measure a uniform distance from the centerline throughout the project as long as the joint does not fall into the widening unit. The measurements should be checked at specified intervals throughout the project to ensure the longitudinal sawcut in the new overlay is above the existing pavement edge within a tolerance of 1 in. where possible (see Figure 20).

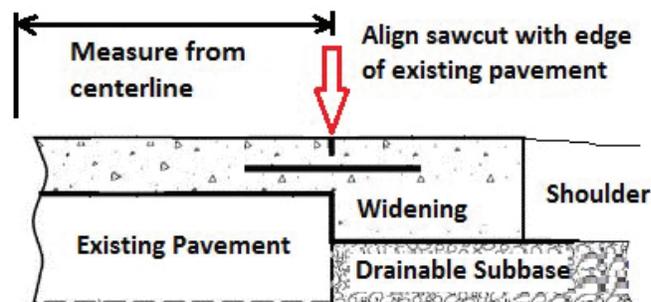


Figure 20. Proper sawcut alignment

Corner Cracking (BCOA, UBCOC, UBCOA)

Interior corner cracking is generally associated with the placement of repeated wheel loads directly on the slab corners, which are the weakest part of each panel (compared to loads placed at an interior location). Corner load placement results from placing a longitudinal joint in one of the wheel paths (see Figure 21).



Figure 21. Interior corner cracking

Other factors that can contribute to the development of excessive corner stresses include panel movement due to asphalt stripping of a concrete overlay on asphalt and/or shear failure of the underlying HMA. The panel movement and asphalt stripping can result in loss of support and loss of bond (for BCOAs) at the slab corner.

Other causes of corner cracking include inadequate surface preparation and slab curling and warping. This results in inadequate mechanical load transfer (UBCOA and UBCOC) due to a lack of dowels, tie bars, and/or aggregate interlock across the longitudinal and transverse joints at the slab corner.

Exterior corner cracking (i.e., cracks that form in the travel lane along the lane-shoulder joint) is a result of the

same mechanisms and factors listed for interior corner cracking, except that the lane-shoulder joint is typically located near, but not directly within, a wheel path. In addition, overlay panels placed adjacent to the shoulder may have very little edge support (i.e., no mechanical load transfer across the lane-shoulder joint) when the shoulder is constructed separately and/or constructed of asphalt (see Figure 22).



Figure 22. Exterior corner cracking

Recommendation: Use Appropriate Slab Dimensions and Design for Adequate Thickness

When laying out panels, it is important that the longitudinal joint is not located near or within the wheel paths wherever possible. Second, it is critical to provide adequate thickness for the overlay. Finally, appropriate slab dimensions should be used to reduce potential curl/warp stresses to negligible levels. This is typically 6 ft x 6 ft or less for UBCOAs ≤ 6 in. thickness.

Ensure that the designed joint layout does not result in panels that exceed the recommended maximum aspect ratio of 1:1.5. A goal should be to keep the ratio of width to length as close to 1.0 as possible. Use the guideline that the length/width of joints in feet is limited to 1.5 times the overlay thickness in inches for overlays < 6 in. and 2.0 times for overlays > 6 in. with a maximum spacing of 15 ft.

It is also important to take steps during design to ensure adequate support of the panel edges, including the use of dowel load transfer devices (for overlays > 7 in.) and tie bars (for overlays > 5 in.).

Differential Horizontal Movement between the Concrete Overlay Mainline and Widening Unit or Paved Concrete Shoulder (UBCOC)

Differential horizontal movement between the concrete overlay mainline and widening unit or shoulders typically results when there is measurable differential restraint between the two and they are not allowed to move in unison. A good example occurs when an UBCOC has an asphalt interlayer and the widening unit

and/or shoulder has a structural base such as a cement-treated base with very restrictive movements or an over-tied widening unit or shoulder. The result, as shown in Figure 23, is longitudinal-diagonal cracking at the transverse joint in the UBCOC, which is referred to as a “smile crack.”



Figure 23. Restraint cracking

This also has been known to result in delamination of the UBCOC above the thickness midpoint. When the pavement has delaminated, additional cracking of the pavement surface is often observed between the original “smile crack” and the nearest outside longitudinal widening unit or shoulder joint.

Recommendation: Eliminate Measurable Differential Horizontal Restraint

Avoid using structural bases for the widening unit or shoulder when the existing pavement does not have the same type of base. One option would be to extend the interlayer under the widening unit or shoulder allowing for the same horizontal movement between overlay and the widening unit or shoulder. See Figure 24 for details.

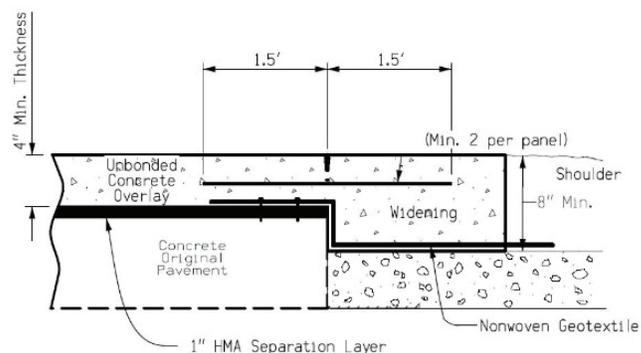


Figure 24. Extending interlayer to outside shoulder

This also allows for the proper drainage of the interlayer to the outside of the pavement section. Utilize No. 4 tie bars between the overlay and widening unit or shoulder. Avoid over-tying with heavier bars or closely spaced bars.

Utilizing Synthetic Structural Fibers for Thin Concrete Overlays

When a thin concrete overlay is required to meet vertical restraints, residual strength is necessary, or tight cracks are needed to provide load transfer between joints. Consideration needs to be given to the use of synthetic fiber reinforcement, particularly for those overlays < 4 in. Used with sufficient dosages and uniform distribution, fibers can help reduce the overlay thickness by increasing toughness (enhanced post-crack flexural performance) and ductility of concrete and providing some flexibility to the designer. They also offer an additional benefit of helping control differential slab movement as a result of temperature changes, curling/warping, or load induced movement. Fibers can span the crack portion below the saw joint. Fibers can also offer an advantage of increased resistance to plastic shrinkage cracking when the concrete is in a plastic state. Figure 25 shows synthetic fibers prior to mixing in concrete.



Figure 25. Synthetic fibers

Recommendation: Consider Fiber Reinforcement for Thin Overlays

Based on the benefits outlined above for overlays ≤ 4 in. thick, it is recommended to calculate thickness necessary with and without fibers. This will provide an understanding of the residual strength gain from the use of fibers. The software program that can be utilized is the BCOA-ME program (Vandenbossche and Sachs 2013). See Figure 26 for a concrete overlay with fibers.



Figure 26. Concrete overlay with synthetic fibers

Selecting the Separation Layer

A separation layer or interlayer is an important feature of unbonded concrete overlay performance. An unbonded overlay needs the separation layer to isolate the existing pavement from the overlay, provide adequate drainage, and serve as a uniform cushion for the overlay to reduce bearing stresses. A typical asphalt separation layer is 1 in. thick, or at least thick enough to provide adequate coverage over irregularities existing in the pavement (see Figure 27).



Figure 27. Asphalt separation layer

The concern with asphalt separator layers is the stripping of the asphalt when the separator layer is poorly drained and experiences heavy truck traffic. Anti-stripping agents may be utilized in the asphalt mix to reduce this potential.

An alternative to the asphalt separation layer is the nonwoven geotextile separation layer which has grown in use for approximately the last 7 to 10 years. Regarding performance, these have proven to be good separation layers, have excellent drainage qualities, and are often less costly than an asphalt interlayer. Because they are very thin, they do provide a benefit when there are vertical constraints.

Both asphalt and nonwoven geotextile separation layers require proper drainage.

Recommendation: Under Equal Conditions, Consider Using Nonwoven Geotextile Interlayer

If the structural condition of the existing concrete pavement is assessed to be adequate, a nonwoven geotextile interlayer is recommended. See Figure 28 for an example of a nonwoven geotextile separation layer.



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Figure 28. White geotextile fabric separation layer

The thickness of the geotextile layer is related to the thickness of the concrete overlay. See Table 4 for recommended geotextile thicknesses.

Table 4. Recommended geotextile thickness

Overlay Thickness	Recommended non-woven geotextile thickness
< 5 in.	13.3 oz./yd ²
≥ 5 in.	14.7 oz./yd ²

Debonding of Overlay from Movement (BCOC)

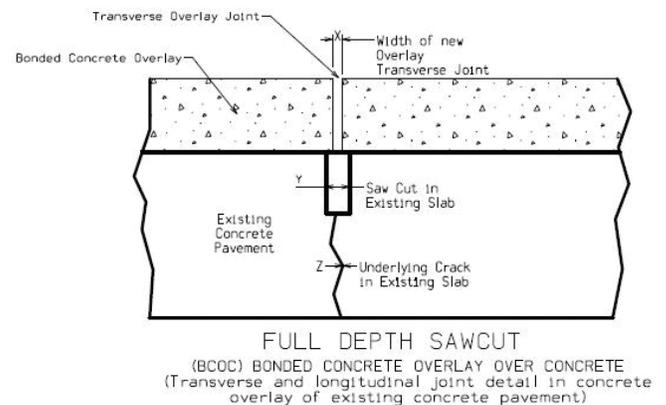
For a bonded concrete overlay on concrete (BCOC) to be successful, it must be placed on a fair to good condition concrete pavement to establish a good bond and behave like a monolithic structure. Upon construction, the newly improved pavement will restore or perhaps slightly increase its structural capacity to provide additional life. It is critical that the overlay joints match the existing pavement joints so that the overlay can move in unison with the underlying concrete pavement. The movement includes expansion and contraction with temperature changes. When the existing concrete and overlay move, they will move together unless the overlay does not have the same or larger joint width. If this occurs, debonding (with cracking) may happen when the overlay pushes against itself (see Figure 29).



Figure 29. Cracking from joint lockup

Recommendation: Match Existing Joints, Saw Full Depth, Evaluate Underlying Pavement Joint

For BCOCs, the joints in the overlay must match the location of the joints in the existing concrete. In addition, the width of the existing underlying pavement crack should be evaluated during design. This can be done by excavating down alongside the edge of the existing pavement. The width of the new transverse joint in the overlay should be equal to or greater than the crack in the existing pavement. This will allow for the monolithic pavement structure to expand and contract without debonding of the overlay. In addition, transverse joints must be sawed full depth plus 0.5 in. and longitudinal joints must be sawed to a depth of at least T/2; some agencies saw the longitudinal joints to full depth plus 0.5 in. (See Figure 30.)



Note: Overlay joint width shall be equal to or greater than crack width of the existing slab. If "Y" is 0.50 in. or greater, the underlying crack width in the existing slab should be measured. If crack "Z" is 0.25 in. or greater, and existing pavement does not have dowel bars, the joints should be evaluated to determine if load transfer rehabilitation is required to eliminate faulting. If there are numerous joints with this condition, the existing pavement may not be a good candidate for a bonded overlay, The existing joints should be filled/sealed to prevent intrusion of mortar during overlay placement. In all cases, "X" must be Z+0.125 in.

Figure 30. Sawcut width on BCOC

Remaining Asphalt (BCOA, UBCOA)

For concrete overlays on asphalt it is important to understand the existing pavement structure to prevent construction damage to the remaining asphalt. This is accomplished by taking cores and evaluating the condition. For a BCOA, the existing asphalt must be in good condition for the overlay to bond to and carry the load. For UBCOAs, the existing asphalt can be in a moderately deteriorated to poor condition, but the asphalt surface must be uniform. It is important to know the thickness of asphalt when milling as part of pre-overlay repairs. If the thickness is not adequate, construction equipment can damage the asphalt leading to the need for additional repairs (see Figure 31).



Figure 31. Construction equipment hauling damage of remaining asphalt after milling

Recommendation: Ensure Minimum Good Asphalt Remaining

It is recommended that a minimum of 3 in. of good condition asphalt remains prior to an UBCOA and a minimum of 4 in. of good condition asphalt remains for a BCOA prior to the overlay. The asphalt must be in good condition or brought up to good condition by milling and patching for the overlay to be successful. If the overlay is thickened in areas of deeper milling, the sawcut depths need to be $T/3$ in the thickened section.

Patching for Pre-Overlay Repairs on Unbonded Concrete Overlays (UBCOA, UBCOC)

With any concrete overlay project, pre-overlay repairs may require full-depth patching. PCC is recommended for patching for durability and ease of operation for the contractor. For unbonded overlays, it is important that the overlay does not bond to the PCC patch when the adjacent panel is asphalt. This allows the overlay above the patch to move similarly to the adjacent lane. The differential movement at the overlay interface will often result in cracking of the overlay.

Recommendation: Place Separation Interface on Patch Areas

To prevent bonding to the overlay at the patch area, it is recommended to install non-woven geotextile fabric over the patch so the new overlay does not adhere to the patch. Figure 32 illustrates a non-woven geotextile fabric placed over an existing concrete widening unit to prevent bonding to the new PCC overlay.



Figure 32. Non-woven geotextile placed over concrete in unbonded overlay

This example has the same intent as placing fabric on a concrete patch area. Placement of a sand seal on the surface of a patch is another option to prevent bonding.

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