National Concrete Pavement Technology Center

November 2014

PERFORMANCE HISTORY OF CONCRETE OVERLAYS IN THE UNITED STATES

IOWA STATE UNIVERSITY
Institute for Transportation

Cover photographs sources: (top) Kevin Merryman, Iowa DOT; (bottom) Todd Hanson, Iowa DOT

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Technical Brief: Performance History of Concrete Overlays in the United States		**5. Report Date** November 2014 **6. Performing Organization Code**
7. Author(s) Gary Fick and Dale Harrington		**8. Performing Organization Report No.**
9. Performing Organization Name and Address National Concrete Pavement Technology Center Institute for Transportation, Iowa State University 2711 South Loop Drive, Suite 4700 Ames, IA 50010-8664		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**
12. Sponsoring Organization Name and Address Federal Highway Administration 1200 New Jersey Avenue, S.E. Washington, D.C. 20590		**13. Type of Report and Period Covered** Technical Brief **14. Sponsoring Agency Code** FHWA DTFH61-12-H-00010
15. Supplementary Notes		

16. Abstract

Concrete overlays are cost-effective, long-lasting solutions for pavement preservation, resurfacing, and rehabilitation and thus should be an integral part of every agency's overall asset management program. The purpose of this brief is to demonstrate the applicability of concrete overlays as an asset management solution on a wide array of existing pavement types and roadway classifications. It does this by providing a brief history of the construction of concrete overlays in the United States and then summarizing the details of 12 concrete overlay projects across the country. It concludes with a short list of additional resources.

17. Key Words		18. Distribution Statement	
concrete overlay — pavement preservation — pavement resurfacing — pavement rehabilitation			
19. Security Classification (of this report) Unclassified.	**20. Security Classification (of this page)** Unclassified.	**21. No. of Pages** 26	**22. Price** NA

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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PERFORMANCE HISTORY OF CONCRETE OVERLAYS IN THE UNITED STATES

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Acknowledgments

This material is based upon work supported by the U.S. Department of Transportation under cooperative agreement No. DTFH61-12-H-00010.

The National Concrete Pavement Technology Center (CP Tech Center) and the authors wish to thank the knowledgeable, experienced, and dedicated concrete pavement experts, both public and private, who serve on an ongoing Technical Advisory Committee for the CP Tech Center's overlay deployment initiative. The committee consists of the following people:

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Mission

The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, technology transfer, and technology implementation.

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Engineers are tasked with providing long-lasting and cost-effective solutions for preserving, rehabilitating, and resurfacing pavements. Meeting these objectives has always been a challenge, but especially now as we face shrinking budgets, escalating material costs, and the desire to provide sustainable solutions. Concrete overlays are cost-effective, long-lasting solutions for pavement preservation, resurfacing, and rehabilitation and thus should be an integral part of every agency's overall asset management program.

The United States has a long history of designing and constructing concrete overlays. With the inclusion of data from NCHRP Syntheses 99 and 204 (NCHRP 1982, NCHRP 1994), the National Concrete Overlay Explorer (ACPA 2014) provides the best historical information on the use of concrete overlays in the country. Although it does not include every concrete overlay project in the United States, this database documents the construction of 1,152 concrete overlays from to 1901 through 2012 in 45 different states. Figure 1 shows the number of concrete overlays constructed in each state from 1910 through 2010.

The purpose of this technical brief is to demonstrate the applicability of concrete overlays as an asset management solution on a wide array of existing pavement types and roadway classifications (primary, secondary, arterial, etc.). In particular, this brief provides background and performance information for 12 concrete overlay projects across the United States to provide engineers with examples of a variety of concrete overlay projects.

Types and Applications of Concrete Overlays

Concrete overlays are either bonded or unbonded. The distinction between bonded and unbonded is strictly a pavement design issue. That is, during the pavement design process, a bonded overlay treats the existing pavement as a structural component, and an unbonded overlay treats the existing pavement as a high-quality (strong and stiff) subbase.

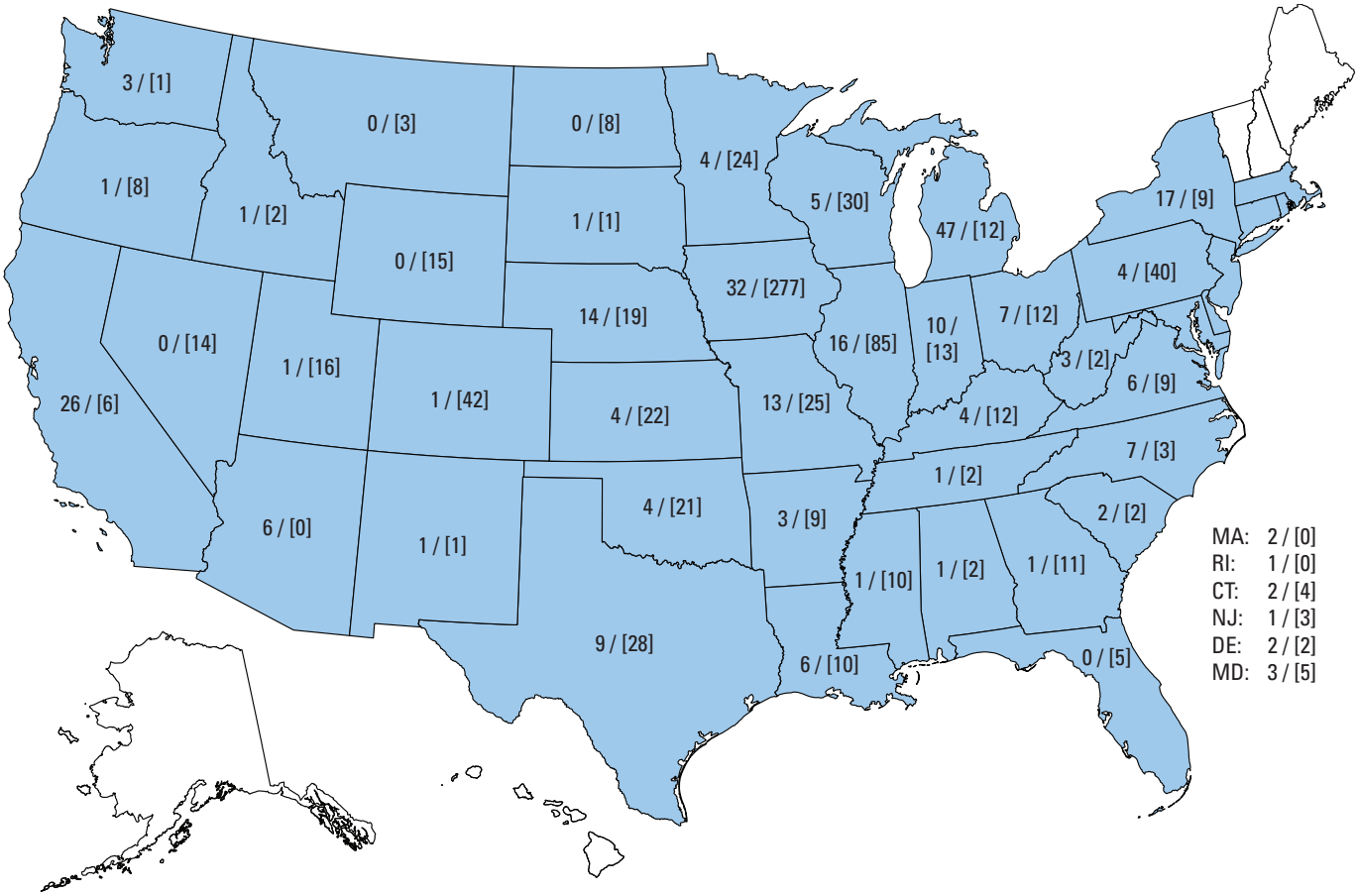


Figure 1. Forty-five states where concrete overlays have been constructed, with number of overlays in each state (1910–1969/[1970–2010])

The *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements* (3rd edition) (Harrington and Fick 2014) adds further clarification regarding the distinction between bonded and unbonded concrete overlays. Regarding bonded overlays, it states

> Bonding between the overlay and the existing pavement is essential. The bond ensures that the overlay and existing pavement perform as one structure, with the original pavement continuing to carry a significant portion of the load. All bonded overlay projects, therefore, are carefully designed and constructed to achieve and maintain a bond between the overlay and the existing pavement.
>
> The term "unbonded" simply means that bonding between the overlay and the underlying pavement is not needed to achieve the desired performance (i.e. the thickness design procedure does not consider the existing pavement as a structural component of the surfacing layer). Thus, the overlay performs as a new pavement, and the existing pavement provides a stable subbase. When the underlying pavement is asphalt or composite, partial or full bonding between the concrete overlay and the underlying asphalt layer should not cause a problem. In fact, such bonding generally adds some load carrying capacity to the system. So, unbonded concrete overlays on existing asphalt or composite pavements are not rigorously designed and constructed to prevent bonding between the layers.
>
> However, when the underlying pavement is concrete, unbonded concrete overlays are carefully designed and constructed to prevent bonding between the two concrete layers. That is because any bonding between the two concrete layers may stress the overlay and result in undesired reflective cracking.

Bonded and unbonded concrete overlays can be applied to any pavement type and are, in fact, subcategorized based on existing pavement type (asphalt, composite, or concrete) (Figure 2).

In addition, concrete overlays can be applied to any functional classification of roadway (Figure 3). Not every project, however, is a candidate for a concrete overlay. A thorough evaluation of existing pavement conditions is necessary to determine whether a concrete overlay is a viable solution and, if so, to select the correct overlay type (bonded or unbonded).

Figure 3. Concrete overlays are an over-arching solution for all pavements

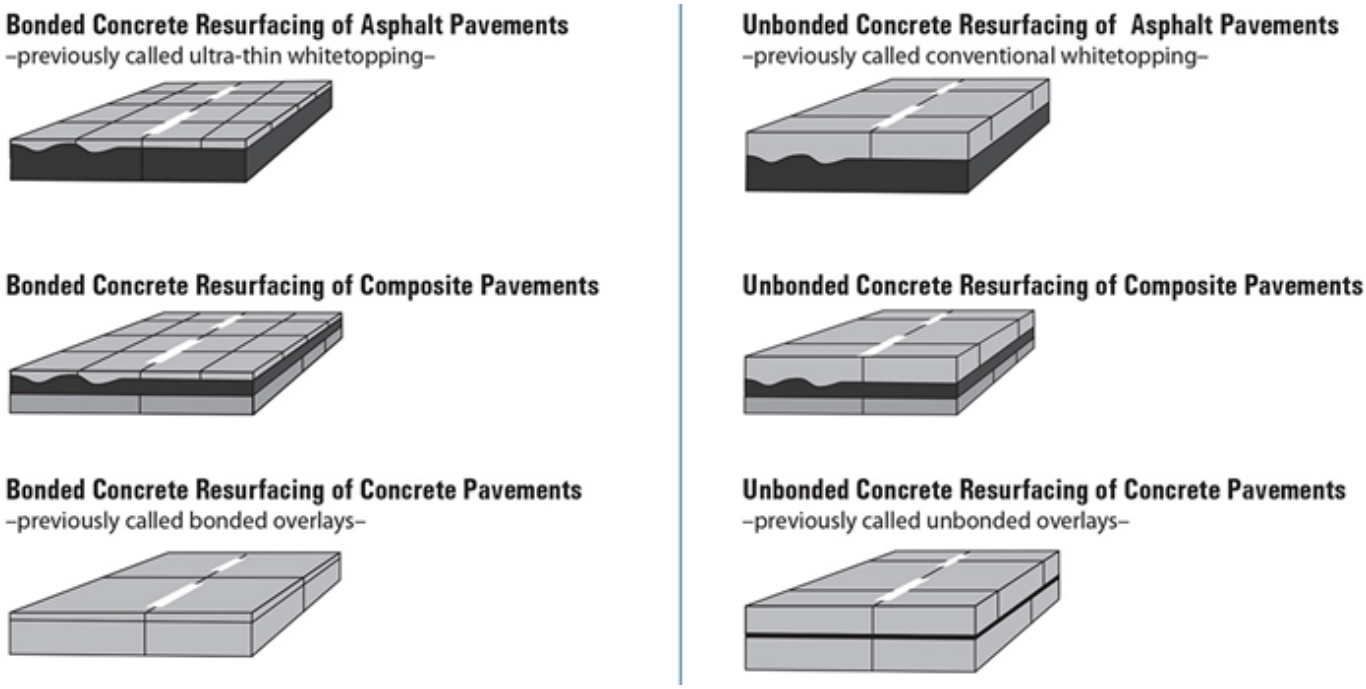


Figure 2. Types of concrete overlays

Sustainable Solutions

Many agencies are emphasizing sustainability in their pavement management decisions (Figure 4). Quantifying the impact of various pavement solutions on the primary sustainability factors of 1) environment, 2) society and 3) economics is difficult at best. However, we can look at the sustainability of concrete overlays from a qualitative perspective and conclude the following:

- Preserving the existing pavement has minimal impact on the environment (e.g., little to no waste products are produced).
- User delays during construction are reduced compared to reconstructing a pavement.
- Concrete overlays can maintain their smoothness for many years, positively affecting the use-phase footprint significantly.
- Concrete overlays often have a lower life-cycle cost than asphalt overlays of equivalent design life.

Concrete overlay pavement systems can be designed for a wide range of design life choices. Rather than removing and reconstructing the original pavement, the owner capitalizes on the existing equity in it, realizing a return on the original investment as long as the original pavement remains part of the system. Resurfacing existing pavements using concrete overlays is a proven sustainable practice.

Figure 4. Concrete overlays support sustainable principles

U.S. Concrete Overlays

As previously mentioned, there are over 1,000 documented concrete overlays in the United States.

The following figures break these projects into various categories and types of overlays constructed over a period of more than 100 years. It is useful to note, however, that currently the trend is shifting to thinner concrete overlays and to more concrete overlays being constructed over existing asphalt pavements.

Figures 5 through 8 are based on data from the years 1900 through 2010 contained in the National Concrete Overlay Explorer (ACPA 2014).

Figure 5 illustrates the increase in number of concrete overlay construction projects by decade. The decrease during the 1960s is most likely due to the focus on new construction associated with build-out of the interstate system.

The percent of each type (bonded or unbonded) of overlay is presented in Figure 6. Unbonded overlays are more widely used than bonded overlays.

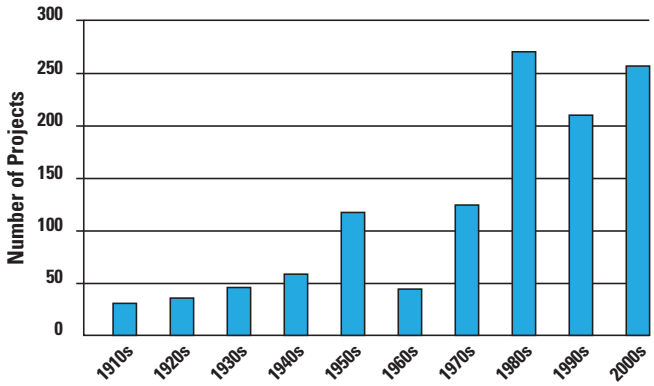


Figure 5. Number of concrete overlay construction projects in the United States by decade

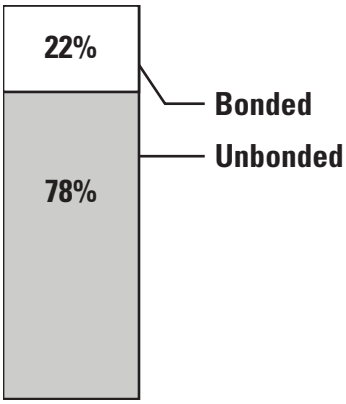


Figure 6. Percentage of each type of concrete overlay constructed from 1900–2010

A breakdown of overlays by existing pavement type is provided in Figure 7. Overlays on both concrete and asphalt pavements are widely used.

A further breakdown of concrete overlay types by existing pavement type is presented in Figure 8. Unbonded concrete overlays on asphalt and on concrete represent nearly three fourths of all concrete overlays documented in the United States.

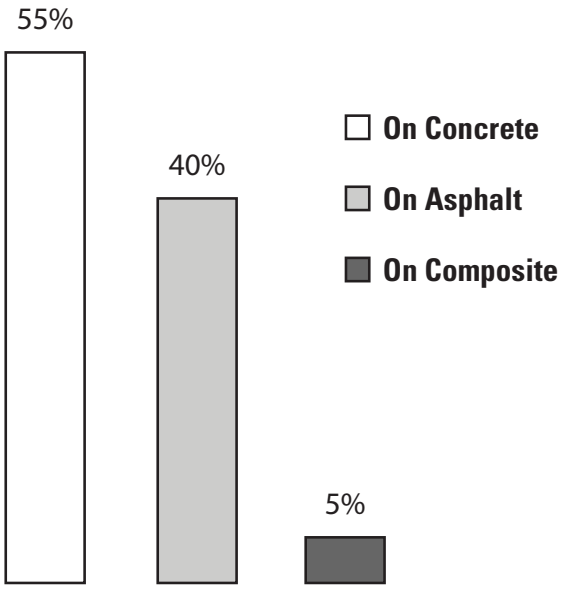


Figure 7. Percentage of concrete overlays by existing pavement type constructed from 1900–2010

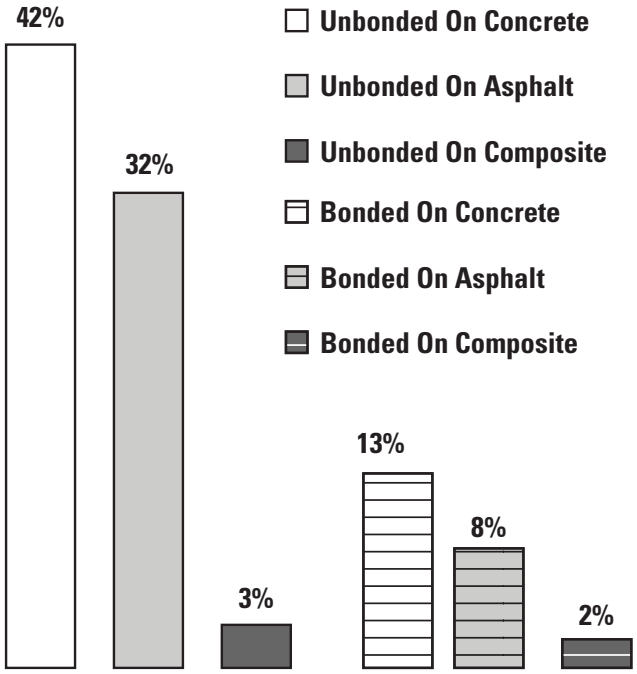


Figure 8. Percentage of bonded and unbonded concrete overlays by pavement type constructed from 1900–2010

Conclusions

For some agencies, perceived barriers to designing and constructing concrete overlays have eliminated overlays from consideration as useful pavement solutions. This should no longer be the case.

Based on the history and experiences of numerous U.S. highway agencies, it is evident that concrete overlays provide a robust solution for maintaining and preserving our nation's pavement assets. There is ample evidence and project experience to support the following statements with regard to concrete overlays:

- They can be constructed under multiple maintenance of traffic strategies: diverted traffic, adjacent to traffic, pilot car operations, etc.
- They are cost-effective solutions. On a volume basis, concrete and asphalt costs are similar, but concrete overlays offer thinner design options that can more easily meet project budget constraints.
- Construction durations are shortened. Eliminating pavement removal, excavation, embankment, subgrade compaction, and subbase/base construction significantly reduces the working days required for a project.
- When needed, pre-overlay maintenance and repairs are straightforward. Standard maintenance procedures are applicable to concrete overlays; thinner overlays can be efficiently milled and repaired/replaced.

Selecting the proper overlay type (bonded or unbonded) for a given existing pavement condition is a key factor in achieving the desired performance. A comprehensive pavement evaluation should be performed as a part of an asset management approach to determine 1) whether a concrete overlay is a feasible design alternative and, if so, 2) what type of concrete overlay is appropriate based on the existing pavement structure and condition.

Because bonded concrete overlays rely on the existing pavement as an integral component for carrying dynamic traffic loads, the existing pavement should be in good condition or economically restored through pre-overlay repairs to a good condition. Conversely, unbonded overlays treat the existing pavement as a base layer and can be placed on deteriorated pavements. Concrete overlays offer a wide range of design life (5 to 50 years); future traffic, concrete overlay thickness, and cost are variables which are critical to achieving the desired performance.

Therefore, performance expectations should be aligned with the available budget and predicted design life.

Selected Case Histories

While it is beneficial to gain an understanding of the history and application of concrete overlays, an engineer tasked with assessing whether a concrete overlay is appropriate for a specific project may still ask: What type of performance can I expect?

In an effort to address this question, especially for agencies that lack extensive experience with designing and constructing concrete overlays, a collection of 12 case histories is presented on pages 6 to 17. These case histories provide varied examples (geography, type, and functional classification) of concrete overlay projects.

The objective of these case histories is twofold:

- Instill confidence that concrete overlays are robust solutions for all types of overlays.
- Dispel any notion that concrete overlays are experimental. At some point, of course, every agency crosses a threshold when designing its first concrete overlay project, but there is ample opportunity to learn from others' experiences and capitalize on lessons learned.

A listing of the 12 case histories is provided in Table 1. States where case study overlays were constructed are shaded in Figure 9.

Table 1. Listing of Case History Projects

Case History #	State	Route	Year Constructed	Existing Pavement &Overlay Type			Functional Classification			
				Asphalt	Composite	Concrete	Interstate, Freeway, or Expressway	Principal or Minor Arterial	Major or Minor Collector	Local
1	OK	US-69	2001	Bonded				YES		
2	MT	US-16	2001	Bonded					YES	
3	IL	Plank Rd	1974	Unbonded						YES
4	CO	US-287	1998	Unbonded				YES		
5	UT	SR-89/114	2001		Bonded					YES
6	IA	SH-13	2002		Bonded				YES	
7	IN	I-69	1986		Unbonded		YES			
8	OK	I-35	2004		Unbonded		YES			
9	IA	V-63	2002			Bonded				YES
10	IL	I-88	1996			Bonded	YES			
11	MI	US-131	1998			Unbonded		YES		
12	NC	I-85	1998			Unbonded	YES			

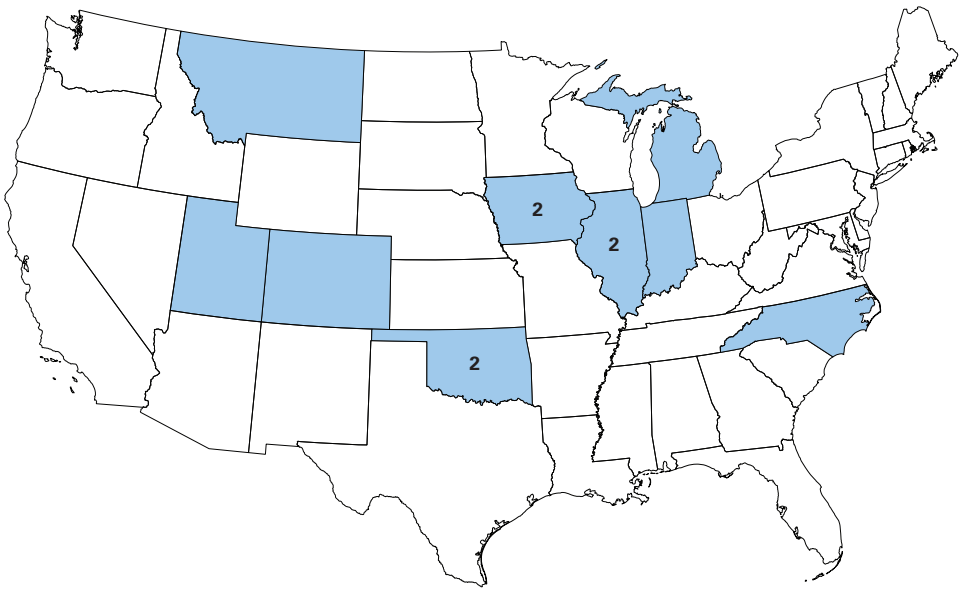


Figure 9. States where case study overlays were constructed (shaded blue)

Case History #1

Performance	
Age	13
Thickness	4″ & 6″
ESALs	10,100,000

Overlay Type Bonded concrete overlay on asphalt pavement

Overlay Thickness 4″& 6″

Location US-69 southbound lanes in Pittsburg County, OK

Year Constructed 2001

Traffic This route serves as a primary freight corridor for trucks serving the Dallas/Ft. Worth metroplex from the north and east.

2011 ADT = 16,000 (two directional movements) (30% trucks)

Estimated ESALs since construction through 2013 = 10,100,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

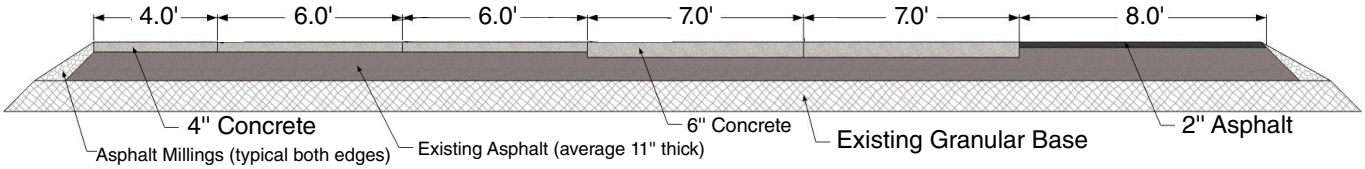
Commentary The existing asphalt pavement was experiencing stability issues (rutting and shoving). There was no indication of stripped layers. Variable depth pre-overlay milling was performed and profile grade was raised approximately 2″.

Construction (2001)

Source: Google Earth 2014

US-69 Looking South (2013)

Typical Section



Contractor	Duit Construction
Engineer	Oklahoma DOT Division I
Owner	Oklahoma DOT
Project Length	≈ 1.5 miles
Overlay Joints	
• **Transverse Spacing**	6′ c/c
• **Longitudinal Spacing**	6′ and 7′
• **Dowel Bars**	No
• **Tie Bars**	No
• **Joint Sealing**	No
Subdrains	No

Existing Subbase Type	Granular
Design Details	Transverse joints sawed T/3 x 1/8″ at 6′ c/c
Fibers (Used/Type/Dosage)	Yes/Macro/3lb. per yard^3
Construction Details	Constructed one lane at a time with traffic adjacent to the paving operation
Pre-Overlay Repairs	None
Observed Distress(es)	2010 -38 slabs (<1%) with visible cracks and joint spalling at centerline
Repairs to Date	Few necessary; some bituminous patches have been placed and minor cracking has been held tight with macro fibers

Case History #2

Performance	
Age	13
Thickness	4″
ESALs	2,200,000

Overlay Type Bonded concrete overlay on asphalt pavement

Overlay Thickness 4″

Location SR-16 in Dawson County, MT

Year Constructed 2001

Traffic This is a three lane urban section in an industrial area, having a grain terminal and truck stop along the route.

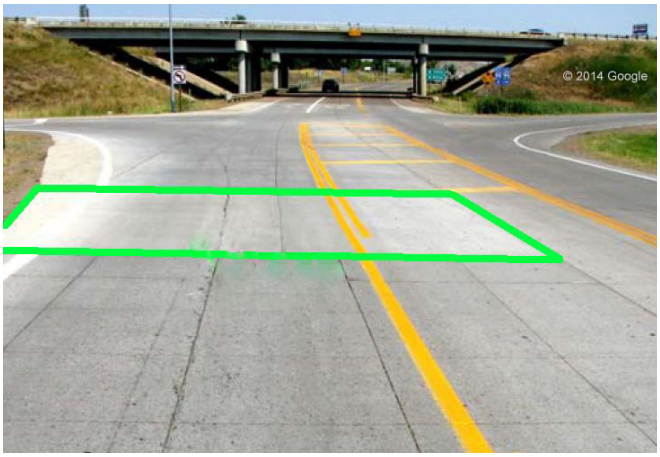
2012 ADT = 4,880 (two directional movements) (15% trucks)

Estimated ESALs since construction through 2013 = 2,200,000 (assumed 2% growth, 50% directional, 100% design lane and a truck factor of 1.4)

Commentary The existing asphalt pavement exhibited rutting, shoving, and thermal cracking. Milling was performed (1½″) and a 4″ bonded concrete overlay was constructed. Some areas had insufficient asphalt remaining after milling and were built up with new asphalt pavement (approximately 2″).

Source: MTDOT Research Construction Report, Feb. 2002, *Thin-Whitetopping Overlay Composite*

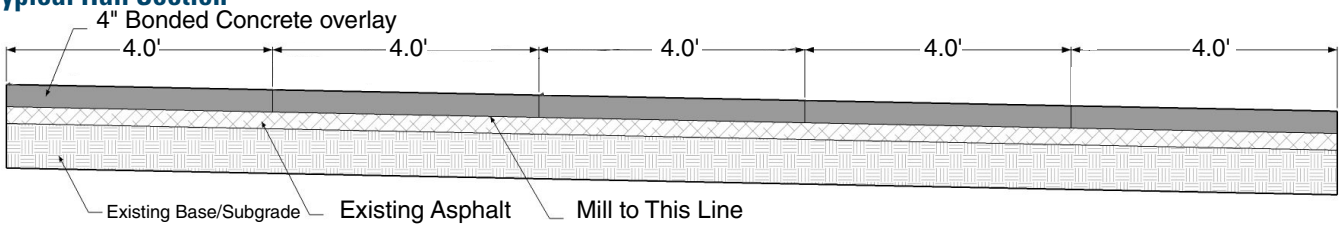
SR-16 Milled Surface Looking North (2001)



Source: MTDOT Experimental Evaluation Final Report, Aug. 2008, *Thin-Whitetopping Bonded Composite*

SR-16 Near the I-94 Interchange (June 2008), Repaired Area (Green)

Typical Half Section



Contractor	Unknown
Engineer	Montana DOT
Owner	Montana DOT
Project Length	≈ 0.6 miles
Overlay Joints	
• **Transverse Spacing**	4′ c/c
• **Longitudinal Spacing**	4′
• **Dowel Bars**	No
• **Tie Bars**	No
• **Joint Sealing**	No
Subdrains	No

Existing Subbase Type	Unknown
Design Details	Raised profile grade approximately 2½″
Fibers (Used/Type/Dosage)	Yes/Macro/3lb. per yard^3
Construction Details	Constructed while maintaining local access
Pre-Overlay Repairs	Asphalt build up in areas where milling exposed base/subgrade
Observed Distress(es)	Approximately 30 (.5%) cracked panels as of 2008
Repairs to Date	Removal and full-depth repair of 15 (.2%) panels in 2005

Case History #3

Performance	
Age	40
Thickness	5" to 7"
ESALs	8,400,000

Overlay Type Unbonded concrete overlay on asphalt pavement

Overlay Thickness 5"to 7"

Location LaSalle County 56 near Peru, IL

Year Constructed 1974

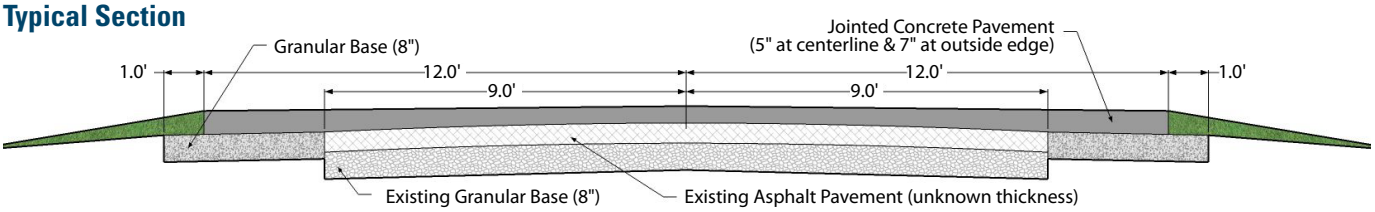
Traffic This is a two lane local route providing access from I-80 to Peru, IL with adjacent industrial facilities.
2012 ADT = 3,850 (two directional movements) (30% trucks)
Estimated ESALs since construction through 2013 = 8,400,000 (assumed 2% growth, 50% directional, 100% design lane and a truck factor of 1.4)

Commentary The existing 18' wide asphalt pavement was widened to 24'. Contrary to current guidance, no reinforcing or longitudinal joint was placed over the edges of the existing pavement. However, no longitudinal cracking occurred.

CR-56 Overlay Construction (1974)

CR-56 After 40 Years (2012)

Typical Section



Contractor	Sjostrom & Sons
Engineer	LaSalle County, IL
Owner	LaSalle County, IL
Project Length	≈ 2.8 miles
Overlay Joints	
• **Transverse Spacing**	15' c/c
• **Longitudinal Spacing**	12'
• **Dowel Bars**	No
• **Tie Bars**	Yes, at centerline joint
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	Granular
Design Details	Thickened widening section
Fibers (Used/Type/Dosage)	No
Construction Details	Constructed one lane at a time with local traffic adjacent to the paving operation
Pre-Overlay Repairs	Unknown
Observed Distress(es)	Faulting and minor cracking
Repairs to Date	Diamond ground after 28 years of service, some patching in the vicinity of a grain elevator

Case History #4

Performance	
Age	13
Thickness	10 ½"
ESALs	3,800,000

Overlay Type Unbonded concrete overlay on asphalt pavement

Overlay Thickness 10 ½"

Location US-287 in Kiowa County, CO

Year Constructed 2001

Traffic US-287 is a part of the "Ports to Plains" freight corridor through Colorado, Oklahoma, and Texas.
2012 ADT = 2,400 (two directional movements) (57% trucks)
Estimated ESALs since construction through 2013 = 3,800,000 (assumed 2% growth, 50% directional, 100% design lane and a truck factor of 1.4)

Commentary This is one of over 20 contracts utilizing concrete paving on this corridor. The existing 24' wide mainline with 8' wide shoulders consisted of a full depth asphalt pavement which was overlaid with an unbonded concrete overlay. The 13 mile project cost $12.6 million in 2001.

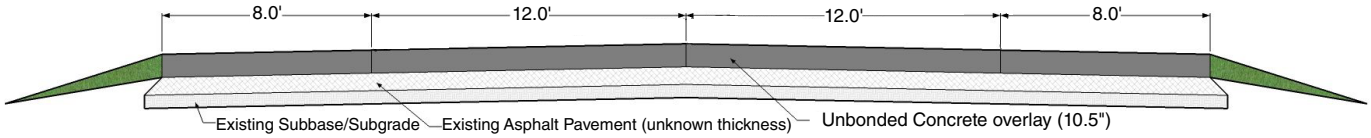
Source: Google Earth 2014

US-287 Looking South (2012)

Source: Google Earth 2014

US-287 With Left Turn Lane Looking South (2012)

Typical Section



Contractor	Castle Rock Construction
Engineer	Colorado DOT
Owner	Colorado DOT
Project Length	≈ 13 miles
Overlay Joints	
• **Transverse Spacing**	15' c/c
• **Longitudinal Spacing**	12'
• **Dowel Bars**	Yes
• **Tie Bars**	Shoulders and centerline
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	Granular
Design Details	No pre-overlay milling; single cut joints (.188"), sealed with silicone
Fibers (Used/Type/Dosage)	No
Construction Details	Constructed under traffic utilizing a pilot car for alternating one-way traffic
Pre-Overlay Repairs	Minimal
Observed Distress(es)	Isolated cracking in the southbound shoulder in 1 location (2012 imagery)
Repairs to Date	Approximately 30 patches (.3%)

Case History #5

Performance	
Age	13
Thickness	4″
ESALs	6,000,000

Overlay Type Bonded concrete overlay on composite pavement

Overlay Thickness 4″

Location US-89 at SR-114 in Utah County, Provo, UT

Year Constructed 2001

Traffic This is an urban section of US-89 in the central business district of Provo, UT approximately 1 mile east of I-15.

2012 ADT = 19,265 (two directional movements) (22% trucks)

Estimated ESALs since construction through 2012 = 6,000,000 (assumed 2% growth, 50% directional, 50% design lane and a truck factor of 1.4)

Commentary The original concrete pavement had been overlaid with asphalt numerous times and widened with full-depth asphalt. Originally designed for a 10 year life, the concrete overlay was replaced after 11 years by a full-depth concrete section in 2012.

CR-56 Overlay Construction (1974)

CR-56 After 40 Years (2012)

Typical Half Section

Contractor	Workman Construction Co.
Engineer	Utah DOT Region 3
Owner	Utah DOT
Project Length	≈ .1 miles
Overlay Joints	
• **Transverse Spacing**	4′ c/c
• **Longitudinal Spacing**	4′
• **Dowel Bars**	No
• **Tie Bars**	No
• **Joint Sealing**	No
Subdrains	No

Existing Subbase Type	Unknown
Design Details	Variable depth milling was used to maintain the existing gutter profile
Fibers (Used/Type/Dosage)	Yes/Macro/3lbs. per yard^3
Construction Details	Weekend construction
Pre-Overlay Repairs	None
Observed Distress(es)	Early cracking around utility structures, ultimately corner and longitudinal cracking caused by repetitive truck loading
Repairs to Date	A few individual panels around utility structures were replaced early in the life of the project

Case History #6

Performance	
Age	12
Thickness	4" nominal
ESALs	1,000,000

Overlay Type Bonded concrete overlay on composite pavement

Overlay Thickness 4" nominal

Location SH-13 from Manchester, IA north approximately 9.6 miles

Year Constructed 2002

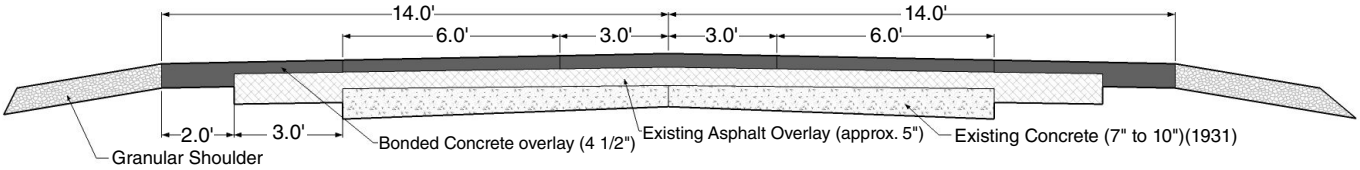
Traffic This is a rural farm-to-market roadway in Delaware County, IA.
2002 ADT = 2,930 (two directional movements) (11% trucks)
Estimated ESALs since construction through 2013 = 1,000,000 (assumed 2% growth, 50% directional, 100% design lane and a truck factor of 1.4)

Commentary The original concrete pavement was constructed in 1931. It was overlaid with 2" of asphalt in 1964, and widened from 18' to 24' and overlaid again with 3" of asphalt in 1984. Approximately ¼" of asphalt was milled prior to construction of the concrete overlay. Although designed as an unbonded on composite, IA SH-13 is included here as an example of a bonded overlay (Sec 51+00 to Sec 208+00) based on the construction methods and follow-up studies, which showed significant bonding to the existing asphalt overlay.

SH-13 Prior to Milling in 2002

SH-13 Bonded Overlay 6'x6' Joint Spacing (2014)

Typical Section



Contractor	Fred Carlson
Engineer	Iowa DOT
Owner	Iowa DOT
Project Length	≈ 9.6 miles
Overlay Joints	
• **Transverse Spacing**	Multiple options used
• **Longitudinal Spacing**	Multiple options used
• **Dowel Bars**	No
• **Tie Bars**	Yes, stapled over widening units
• **Joint Sealing**	No
Subdrains	Partial extents

Existing Subbase Type	Natural subgrade
Design Details	Widened section with thickened edges, multiple research sections were incorporated in this project
Fibers (Used/Type/Dosage)	Monofilament (1lb/yd^3)/ Fibrillated (3lbs/yd^3)/Structural (3lbs/yd^3)
Construction Details	Milled surface sprayed with water when temperatures exceeded 100°F
Pre-Overlay Repairs	Milling
Observed Distress(es)	Longitudinal cracking, primarily attributed to the use of tooled joints
Repairs to Date	Minimal

Case History #7

Performance	
Age	28
Thickness	11″
ESALs	47,500,000

Overlay Type Unbonded concrete overlay on composite pavement

Overlay Thickness 11″

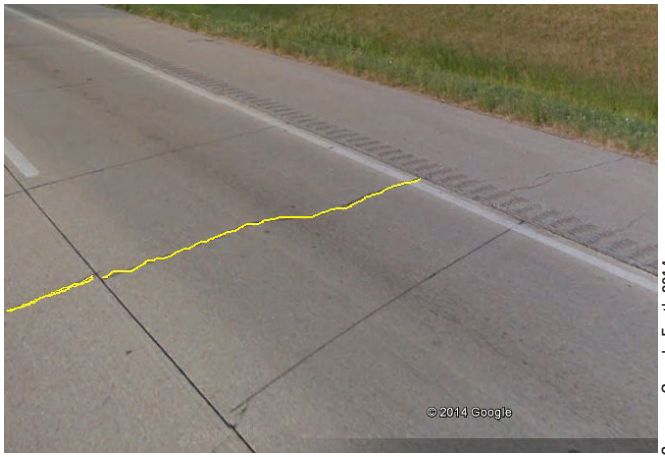
Location I-69 north of SR-18 in Grant County, IN

Year Constructed 1986

Traffic I-69 is a major freight corridor connecting Indianapolis to I-80 and I-94 to the north.
2013 ADT = 26,000 (two directional movements) (estimated 42% trucks)
Estimated ESALs since construction through 2013 = 47,500,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

Commentary The existing concrete pavement suffered from d-cracking and had been overlaid with asphalt. The asphalt overlay(s) were milled to a crowned section and a new 1″ thick asphalt interlayer was placed prior to constructing the concrete overlay.

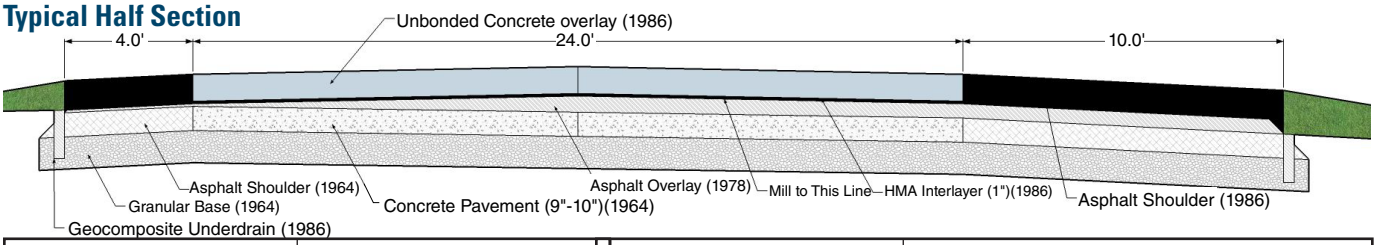
I-69 After Grinding (2005)



Source: Google Earth 2014

Typical Mid-Panel Crack After 27 Years (Aug. 2013)

Typical Half Section



Contractor	Lockhart
Engineer	Indiana DOT
Owner	Indiana DOT
Project Length	≈ 4.6 miles
Overlay Joints	
• **Transverse Spacing**	Random (avg. 15′ c/c)
• **Longitudinal Spacing**	12′
• **Dowel Bars**	No
• **Tie Bars**	Yes, at centerline joint
• **Joint Sealing**	Yes
Subdrains	Yes, geocomposite

Existing Subbase Type	Granular
Design Details	1″ HMA interlayer placed over milled asphalt overlay (existing)
Fibers (Used/Type/Dosage)	No
Construction Details	Milled existing asphalt overlay from constant cross-slope to crowned section
Pre-Overlay Repairs	Minimal
Observed Distress(es)	Mid-panel, longitudinal, and corner cracking. Cracked slabs ≈ 2% estimated from 2012/13 imagery
Repairs to Date	Full-depth patching ≈ 2%. Grinding after 19 years (2005). Full-depth patching planned for 2015 (4%)

Case History #8

Performance	
Age	10
Thickness	11½
ESALs	19,100,000

Overlay Type Unbonded concrete overlay on composite pavement

Overlay Thickness 11½"

Location I-35 7 miles north of Texas state line in Love County, OK

Year Constructed 2004

Traffic I-35 is a major freight corridor connecting Oklahoma City and Dallas.
2011 ADT = 28,400 (two directional movements) (estimated 41% trucks)
Estimated ESALs since construction through 2013 = 19,100,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

Commentary The existing concrete pavement had been overlaid with approximately 4" of asphalt. After milling 2" of asphalt, the remainder served as an interlayer between the new concrete overlay and the existing JPCP.

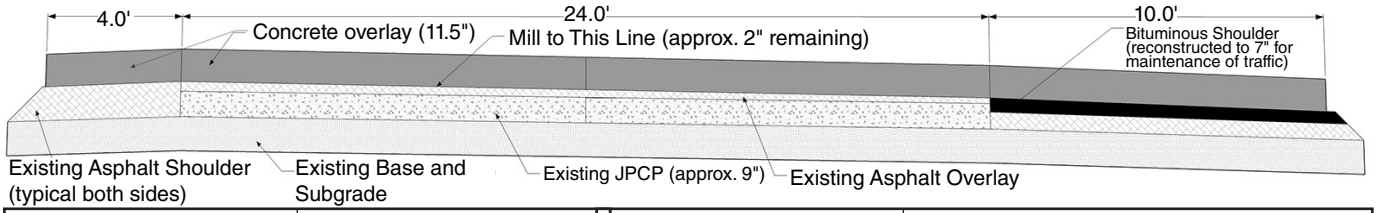
Source: Google Earth 2014

I-35 Looking North (Feb. 2014)

Source: Google Earth 2014

I-35 Looking South (Oct. 2013)

Typical Section



Contractor	Western Plains
Engineer	Oklahoma DOT
Owner	Oklahoma DOT
Project Length	≈ 3.5 miles
Overlay Joints	
• **Transverse Spacing**	15' c/c
• **Longitudinal Spacing**	12'
• **Dowel Bars**	Yes
• **Tie Bars**	Yes, centerline & shoulders
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	Unknown
Design Details	Cross-slopes were changed from 1.5% to 2% during the milling operation
Fibers (Used/Type/Dosage)	No
Construction Details	The asphalt shoulder on the southbound lane was reconstructed prior to the overlay to maintain traffic
Pre-Overlay Repairs	Plan quantity included 50 yd^2 of full-depth patching
Observed Distress(es)	None
Repairs to Date	None

Case History #9

Performance	
Age	12
Thickness	4″
ESALs	150,000

Overlay Type Bonded concrete overlay on concrete pavement

Overlay Thickness 4″

Location V-63 in Jefferson County, IA

Year Constructed 2002

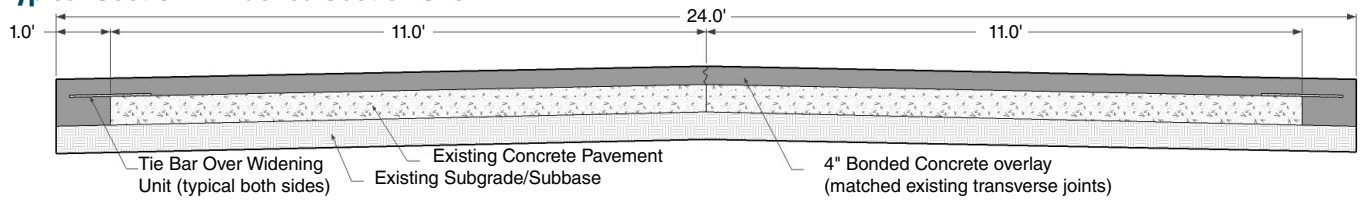
Traffic Local farm-to-market route.
2013 ADT = 1,160 (two directional movements) (estimated 5% trucks)
Estimated ESALs since construction through 2013 = 150,000 (assumed 2% growth, 50% directional, 100% design lane and a truck factor of 1.4)

Commentary V-63 is a county route in southern Iowa. The existing pavement was shotblasted and overlaid with 4″ of concrete. The centerline joint was not sawed and allowed to reflect through from the underlying pavement.

V-63 Condition of Adjacent Pavement Without Bonded Overlay (2014)

TV-63 Current Condition (2014)

Typical Section - Widened Section Shown



Contractor	K Cunningham/Cedar Falls
Engineer	Jefferson County
Owner	Jefferson County
Project Length	≈ 5.1 miles
Overlay Joints	
• **Transverse Spacing**	20′ c/c
• **Longitudinal Spacing**	11′
• **Dowel Bars**	No
• **Tie Bars**	Over widened section
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	Unknown (either granular or natural subgrade)
Design Details	The northernmost mile was widened integrally with the overlay, a tie bar was placed over the existing pavement, but no joint was sawn
Fibers (Used/Type/Dosage)	No
Construction Details	Transverse joints sawed full depth plus ½″
Pre-Overlay Repairs	Minimal
Observed Distress(es)	Transverse cracking and joint shadowing, fewer than 1% cracked slabs
Repairs to Date	Cracked sealing

Case History #10

Performance	
Age	18
Thickness	3″
ESALs	16,800,000

Overlay Type Bonded concrete overlay on concrete pavement

Overlay Thickness 3″

Location I-88 in Whiteside County, IL

Year Constructed 1996

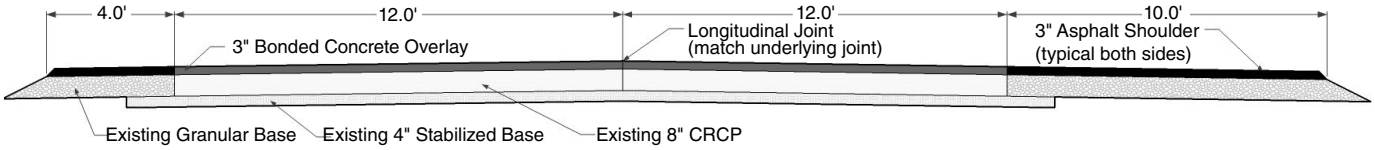
Traffic Major east-west route from Chicago, IL to the Quad Cities.
2013 ADT = 16,800 (two directional movements) (estimated 24% trucks)
Estimated ESALs since construction through 2013 = 16,800,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

Commentary The existing 8″ thick CRCP was milled and shotblasted prior to placement of the 3″ thick unreinforced bonded concrete overlay.

I-88 Bonded Overlay Construction (1996)

Eastbound I-88 Looking West (2011)

Typical Section



Contractor	McCarthy Improvement
Engineer	Illinois DOT
Owner	Illinois DOT
Project Length	≈ 3.1 miles
Overlay Joints	
• **Transverse Spacing**	None (continually reinforced)
• **Longitudinal Spacing**	12′
• **Dowel Bars**	No
• **Tie Bars**	No
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	4″ Stabilized
Design Details	Asphalt shoulders
Fibers (Used/Type/Dosage)	No
Construction Details	Shotblast and milling surface preparation
Pre-Overlay Repairs	Minimal
Observed Distress(es)	Debonding and subsequent structural failure at a few isolated locations
Repairs to Date	25 (.5%) full depth patches

Case History #11

Performance	
Age	16
Thickness	±7″
ESALs	8,000,000

Overlay Type Unbonded concrete overlay on concrete pavement

Overlay Thickness ±7″

Location US-131 southbound lanes in Allegan County, MI

Year Constructed 1998

Traffic Primarily north-south route in western Michigan, connecting to I-94 and I-80 to the south.
2013 ADT = 29,600 (two directional movements) (estimated 10% trucks)
Estimated ESALs since construction through 2013 = 8,000,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

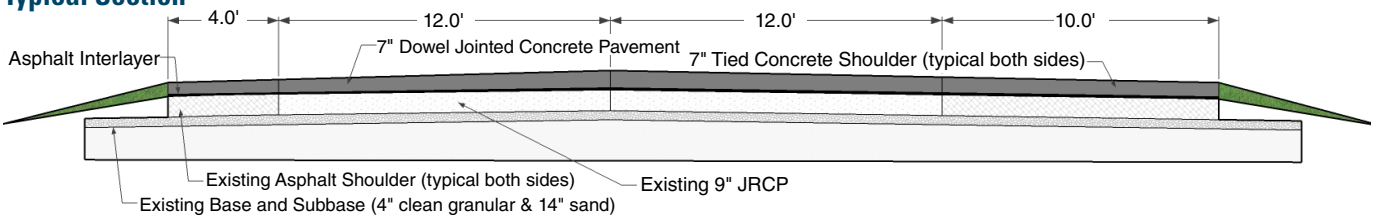
Commentary The original pavement was an early 1960s vintage JRCP with transverse joints at 99′ c/c. The concrete overlay was constructed with a 1″ thick dense graded asphalt interlayer (Michigan DOT has subsequently changed to a drainable asphalt interlayer). Tied concrete shoulders combined with sandy soils have proven adequate for support.

US-131 During Construction (1960s)

Source: Google Earth 2014

US-131 Northbound Lanes Looking South (Sep. 2012)

Typical Section



Contractor	Interstate Highway
Engineer	Michigan DOT
Owner	Michigan DOT
Project Length	≈ 4 miles
Overlay Joints	
• **Transverse Spacing**	13′
• **Longitudinal Spacing**	12′
• **Dowel Bars**	Yes
• **Tie Bars**	Yes, centerline & shoulders
• **Joint Sealing**	Yes
Subdrains	No

Existing Subbase Type	4″ clean granular on 14″ sand
Design Details	Tied concrete shoulders provide additional edge support; 40% GGBFS in the concrete mixture
Fibers (Used/Type/Dosage)	No
Construction Details	Constructed adjacent to traffic; crown correction made with variable thickness concrete
Pre-Overlay Repairs	None
Observed Distress(es)	.8 mile long section of the northbound inside lane with early joint deterioration
Repairs to Date	18 (.3%) patches and 24 (.4%) cracked slabs that have been sealed

Case History #12

Performance	
Age	13–17
Thickness	10″
ESALs	17,500,000

Overlay Type Unbonded concrete overlay on concrete pavement

Overlay Thickness 10″

Location I-85 in Granville County, NC

Year Constructed Three projects from 1997 to 2001

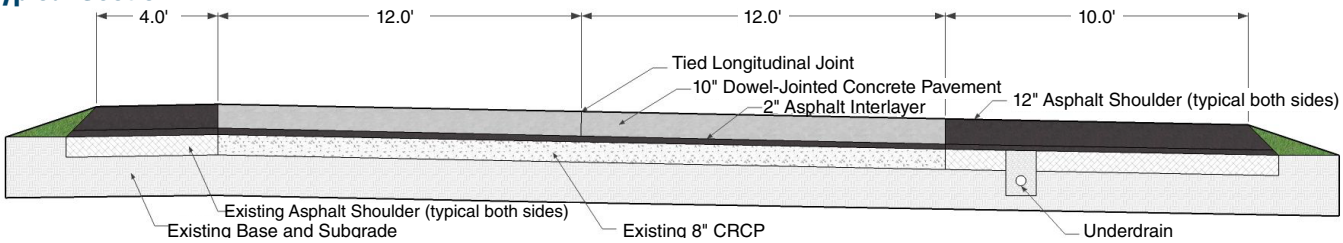
Traffic A major freight corridor from Raleigh-Durham, NC north to Richmond, VA.
2012 ADT = 29,000 (two directional movements) (estimated 25% trucks)
Estimated ESALs since construction through 2013 = 17,500,000 (assumed 2% growth, 50% directional, 75% design lane and a truck factor of 1.4)

Commentary The original pavement was 1970s 8″ CRCP with punchouts and longitudinal cracking. Two of the 10″ unbonded concrete overlay sections were constructed with a 2″ thick dense graded asphalt interlayer and the third section utilized a 2″ thick permeable asphalt interlayer.

Typical Condition of I-85 Prior to Overlay Construction

Northbound I-85 (July 2013)

Typical Section



Contractor	APAC Tennessee/ Southern Roadbuilders
Engineer	North Carolina DOT
Owner	North Carolina DOT
Project Length	≈ 17.3 miles
Overlay Joints	
• **Transverse Spacing**	Average 20′
• **Longitudinal Spacing**	12′
• **Dowel Bars**	Yes
• **Tie Bars**	Yes, at centerline joint
• **Joint Sealing**	Yes
Subdrains	Yes

Existing Subbase Type	Unknown
Design Details	Design thickness is a nominal 1″ thinner than typical NCDOT reconstruction alternative
Fibers (Used/Type/Dosage)	No
Construction Details	Two projects constructed adjacent to traffic and the third was paved 24′ wide
Pre-Overlay Repairs	Minimal
Observed Distress(es)	Mid-panel cracking (1.5%), 98% of cracked slabs are in the first project constructed
Repairs to Date	Full-depth patching (.2%) and crack sealing

Additional Resources

The resources described below are recommended for obtaining in-depth guidance on the design and construction of concrete overlays.

CP Tech Center Resources

The following documents and other resources have been developed by the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University and can be downloaded at www.cptechcenter.org/.

Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements (3rd edition) (Harrington and Fick 2014). The primary goal of this guide is to fill the knowledge gap about concrete overlays so that pavement owners can confidently include concrete overlays in their toolbox of pavement solutions and make more informed decisions about designing and constructing them. Another goal is to help owner agencies understand and appreciate the versatility of concrete overlay solutions. This is not a complete step-by-step manual, nor does it provide prescriptive formulae or specifications for designing and constructing concrete overlays. Rather, as the title suggests, this booklet provides expert guidance that can supplement practitioners' own professional experience and judgment. In particular, this edition of the guide enhances original material with updated information on the following topics:

- Evaluating existing pavements to determine if they are good candidates for concrete overlays
- Selecting the appropriate overlay system for specific pavement conditions
- Managing concrete overlay construction work zones under traffic
- Accelerating construction of concrete overlays when appropriate

Guide to the Design of Concrete Overlays Using Existing Methodologies (Torres et al. 2012). This guide provides decision makers and practitioners with straightforward, simple guidance for the design of concrete overlays using existing methodologies.

The guide focuses on four commonly used methods:

- The method described in the 1993 AASHTO Guide for Design of Pavement Structures (4th Edition) (AASHTO 1993)
- The method described in the Mechanistic-Empirical Pavement Design Guide—A Manual of Practice (interim edition) (AASHTO 2008)
- The ACPA modified method for bonded concrete overlays of asphalt pavements
- The Colorado Department of Transportation method for bonded concrete overlays of asphalt pavements (Tarr et al. 1998, Wu and Sheehan 2004)

The guide discusses specific design assumptions, deficiencies, and strengths inherent in each method, as well as step-by-step design examples for typical pavement sections that are viable concrete overlay candidates. It is intended to be used with the corresponding design procedures' documentation references, such as the 1993 AASHTO Guide for Design of Pavement Structures (4th edition) and/or computer software for the AASHTO Mechanistic-Empirical Pavement Design Guide and ACPA methods.

Concrete Overlay Field Application Program Final Report: Volume I (Fick and Harrington 2012). The National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University conducted a four-year, multi-state concrete overlay construction program to demonstrate and document the concept and benefits of various concrete overlay applications and provide real-world lessons. Teams of CP Tech Center / FHWA experts completed 26 field site visits in 18 states and provided workshops or technical assistance on overlay projects in six additional states. The site visits included four open house demonstration projects. A report with recommendations was prepared for each of the site visits. As a result of the site visits and recommendations, concrete overlays were either constructed or scheduled for construction in nine states, and the teams provided additional advice and assistance as requested during the course of these projects. During the site visits, workshops, project planning, and construction, the teams recognized opportunities to improve concrete overlay projects for a variety of applications, and the final report includes an overview of these lessons learned. Volume I of this final report outlines the field applications program purpose, activities, and results/lessons learned.

Volume II includes copies of all documents prepared during the course of the program.

Concrete Overlay Field Application Program Iowa Task Report: US 18 Concrete Overlay Construction Under Traffic (Cable 2012). The National Concrete Pavement Technology Center, Iowa Department of Transportation, and Federal Highway Administration set out to demonstrate and document the design and construction of Portland cement concrete (PCC) overlays on two-lane roadways while maintaining two-way traffic. An 18.82 mile project was selected for 2011 construction in northeast Iowa on US 18 between Fredericksburg and West Union. This report documents planning, design, and construction of the project and lessons learned. The work included the addition of subdrains, full-depth patching, bridge approach replacement, and drainage structural repair and cleaning prior to overlay construction. The paving involved surface preparation by milling to grade and the placement of a 4.5 inch PCC overlay and 4 foot of widening to the existing pavement. In addition, the report makes recommendations on ways to improve the process for future concrete overlays.

Online Library of Concrete Overlay Plans, Specifications, and Cost Summaries. Full plan sets and special provisions of recent (2010 and later) concrete overlay projects are being collected into an online library (scheduled publication early 2015). These resources can provide information about specific design details, maintenance of traffic schemes, materials specifications, costs, etc., to help agencies successfully design and construct concrete overlay projects. The library will be organized by overlay type and will be updated regularly as projects are completed and materials become available.

Industry and University Resources

The concrete paving industry has developed a number of resources associated with concrete overlays, these include, but are not limited to the following:

National Concrete Overlay Explorer (ACPA 2014). This online database of concrete overlay projects provides information by map view, table view, and details view. Photos of many projects are included. The table view lists type of overlay and specific application, state, year constructed, and overlay thickness, with links to project details.

Case Studies of Concrete Inlay/Overlay Projects (CPAM [no year]). The Concrete Paving Association of Minnesota provides nine concrete overlay project case studies in .pdf (portable document format) for download.

Mechanistic-Empirical Design Procedure for Bonded Concrete Overlay of Asphalt (Vandenbossche 2013). The bonded concrete overlay of asphalt mechanistic-empirical design procedure (BCOA-ME) was developed at the University of Pittsburgh under the FHWA Pooled Fund Study TPF 5(165). This type of pavement system has also been referred to as thin and ultra-thin whitetopping. The website is a repository of all information relating to the BCOA-ME.

References

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Tarr, S.M., Sheehan, M.J., and Okamoto, P.A. (1998). *Guidelines for the Thickness Design of Bonded Whitetopping Pavements in the State of Colorado*, Colorado Department of Transportation, Denver, CO.

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