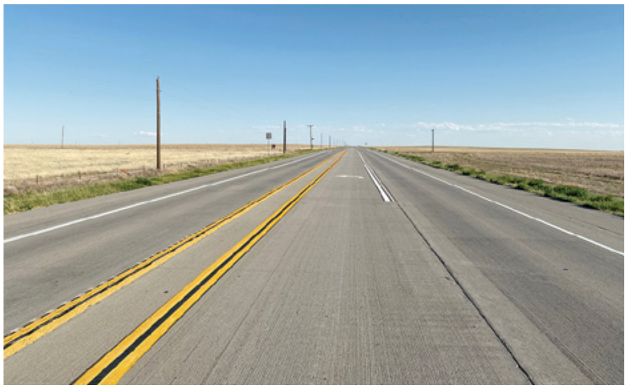
PERFORMANCE HISTORY OF CONCRETE OVERLAYS IN THE UNITED STATES



IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

CP Tech Center

JUNE 2023

About the CP Tech Center

The mission of the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University 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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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 document 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 17 concrete overlay projects across the country. It concludes with a short list of additional resources.

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Performance History of Concrete Overlays in the United States

June 2023

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Introduction

An important task that engineers in highway agencies perform is to identify long-lasting and cost-effective solutions for preserving, rehabilitating, and resurfacing pavements. Meeting these objectives can be a challenge, however, especially with tight budgets, escalating material costs, and the desire for agencies to provide sustainable solutions.

Concrete overlays can offer public agencies an economical, long-lasting solution for extending the life of an existing asphalt, composite, or concrete pavement and can contribute to an agency's overall asset management program. Concrete overlays are adaptable to a broad range of pavement conditions and project needs, and their historical performance can make them an attractive option for addressing a variety of pavement preservation and rehabilitation scenarios.

This document summarizes performance information for 17 concrete overlay projects from across the United States to demonstrate the applicability of concrete overlays as an asset management solution on a wide array of existing pavement types and roadway classifications. This document is an updated version of a previously published technical brief (Fick and Harrington 2014). The 12 project summaries presented in the original version have been updated and 5 new summaries have been added to reflect the latest experience with concrete overlays in the United States.

Types and Applications of Concrete Overlays

Concrete overlays are either bonded or unbonded. During the pavement design process, a bonded overlay design treats the existing pavement as a structural component, and an unbonded overlay design treats the existing pavement as a high-quality (strong and stiff) subbase.

Bonded overlay projects are designed and constructed to achieve and maintain a bond between the overlay and the existing pavement. 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.

For unbonded overlay projects, bonding between the overlay and the underlying pavement is not used to achieve the desired performance; that is, 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; such bonding generally adds some load-carrying capacity to the system. For this reason, concrete on asphalt–unbonded (COA–U) overlays are not typically designed and constructed to prevent bonding between the layers.

When the underlying pavement is concrete, unbonded concrete overlays are specifically designed and constructed to prevent bonding between the two concrete layers. This is because any bonding between the two concrete layers may stress the overlay and result in reflective cracking.

Bonded and unbonded concrete overlays can be applied to any pavement type and are, in fact, subcategorized based on existing pavement type (Figure 1).

In addition, concrete overlays can be applied to any functional classification of roadway. 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).

Sustainable Solutions

Many agencies are emphasizing sustainability in their pavement management decisions (Figure 2).

Quantifying the impact of various pavement solutions on the primary sustainability factors of environment, society, and economics is difficult at best. From a qualitative perspective, however, concrete overlays can offer the following sustainability benefits:

- Minimized impact on the environment (e.g., few to no waste products produced, reduced fuel consumption from construction activities).
- Reduced user delay during construction when compared to pavement reconstruction.
- Maintenance of smoothness for many years, reducing the use-phase carbon footprint.
- Lower life-cycle costs than asphalt overlays of equivalent design life.

Concrete overlay pavement systems can be designed for a wide range of design life choices. By placing a concrete overlay rather than removing and reconstructing the original pavement, the owner capitalizes on the existing pavement's equity, realizing a return on the original investment given that the original pavement remains part of the system. In this and other ways, resurfacing existing pavements using concrete overlays can be a sustainable practice.

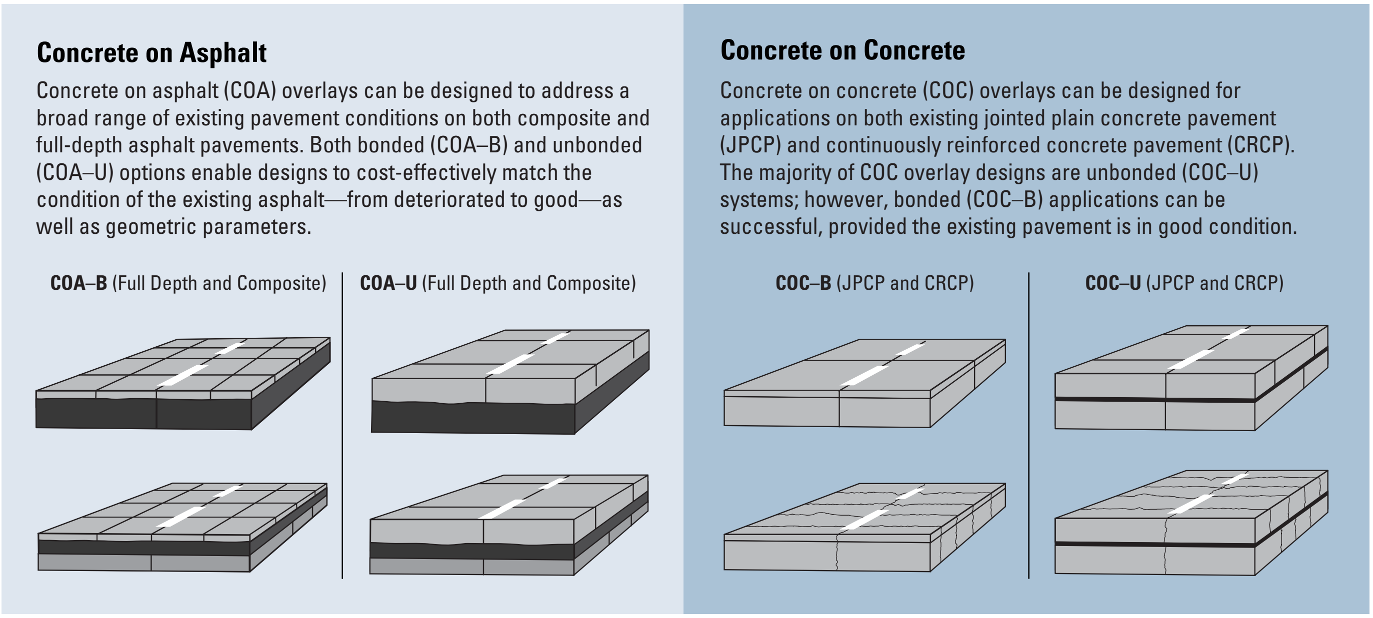

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Figure 1. Types of concrete overlays

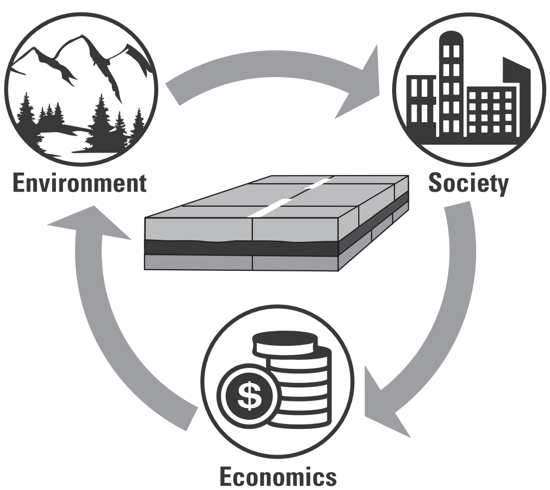

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Figure 2. Ways that concrete overlays can support sustainable principles

Concrete Overlays in the United States

The United States has a long history of designing and constructing concrete overlays. Based on data from National Cooperative Highway Research Program (NCHRP) Syntheses 99 and 204 (Hutchinson 1982, McGee 1994), the National Concrete Overlay Explorer (ACPA 2020) identifies 1,289 concrete overlays constructed from 1910 through 2017 in 46 States. Figure 3 shows the number of concrete overlays constructed in each State from 1910 through 2022.

Based on data from the National Concrete Overlay Explorer (ACPA 2020) for the years 1900 through 2020, the following figures illustrate the trends in concrete overlay construction and break these projects into various categories.

Figure 4 illustrates the general increase in the number of concrete overlay construction projects each decade since 1900. The decrease during the 1960s may be due to the focus on new construction associated with the build-out of the Interstate system. The percent of each type of concrete overlay (bonded or unbonded) is presented in Figure 5. A breakdown of concrete overlays by existing pavement type is presented in Figure 6.

A breakdown of concrete overlays by both overlay type and existing pavement type is presented in Figure 7. COA–U overlays and concrete on concrete–unbonded (COC–U) overlays represent over three-fourths of all concrete overlay construction projects documented in the United States.

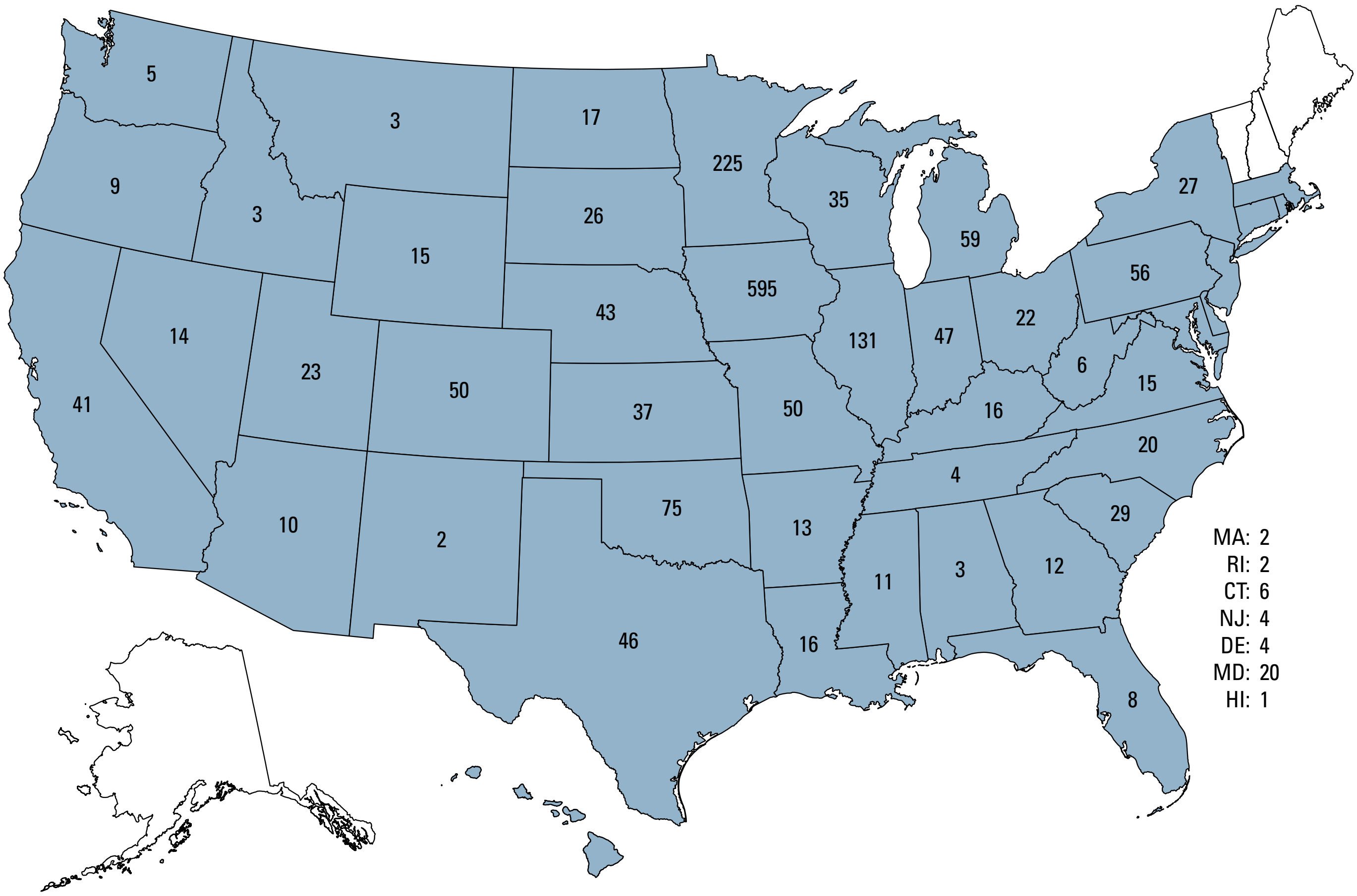

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Figure 3. Concrete overlays constructed in the United States from 1910 through 2022

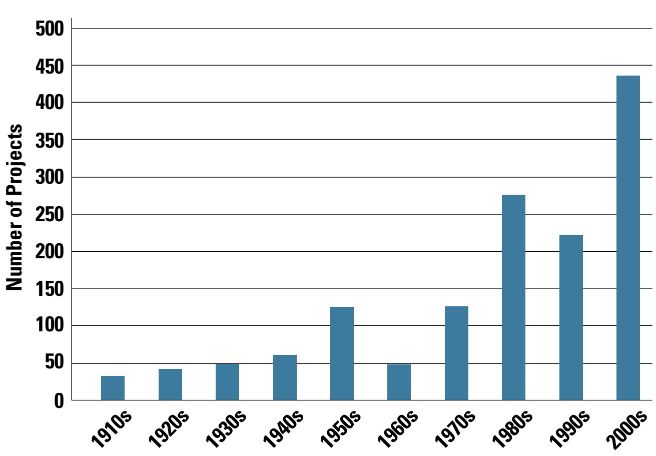

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Figure 4. Number of concrete overlay construction projects in the United States by decade

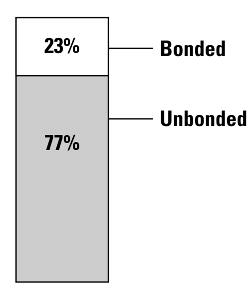

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Figure 5. Percentage of each type of concrete overlay constructed from 1900 through 2020

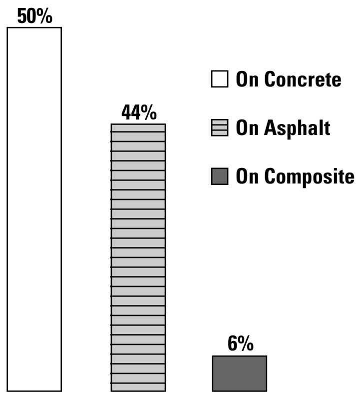

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Figure 6. Percentage of concrete overlays constructed from 1900 through 2020 by existing pavement type

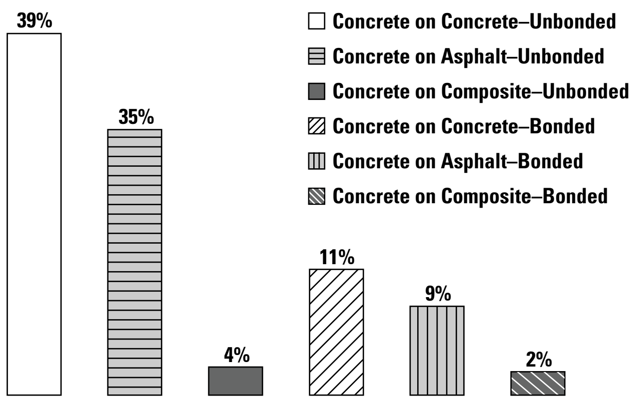

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Figure 7. Percentage of bonded and unbonded concrete overlays constructed from 1900 through 2020 by existing pavement type

Conclusions

Based on the histories and experiences of numerous highway agencies in the United States, concrete overlays provide a robust solution for maintaining and preserving the Nation's pavement assets for the following reasons:

- They can be constructed under multiple maintenance of traffic strategies: diverted traffic, adjacent to traffic, pilot car operations, and others.
- They can be cost-effective solutions. Concrete and asphalt costs are similar in terms of volume, but concrete overlays can offer thinner design options that may more easily meet project budget constraints.
- They can shorten construction durations. Eliminating pavement removal, excavation, embankment, subgrade compaction, and subbase/base construction can reduce the working days needed for a project.

When needed, pre-overlay maintenance and repairs are straightforward. Standard maintenance procedures are applicable to concrete overlays, and 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 part of an asset management approach to determine (1) whether a concrete overlay is a feasible design alternative and, if so, (2) the appropriate type of concrete overlay 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, for bonded overlays 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 durations (typically 20 up to 50 years); future traffic volumes, the thickness of the concrete overlay, and cost are critical variables for achieving the desired performance throughout the overlay's design life. Therefore, performance expectations should be aligned with the available budget and predicted design life.

Selected Case Histories

The collection of 17 case histories presented below provides a variety of examples of concrete overlay projects in terms of geography, overlay type, and roadway functional classification.

The goals of presenting these case histories are as follows:

- Instill confidence that concrete overlays are robust solutions for most types of pavements.
- Demonstrate that concrete overlays are not experimental; the case histories presented below are examples of successful performance.

Case Histories 1 through 12 were included in the original version of this document (Fick and Harrington 2014) and have been updated. Case Histories 13 through 15 have been added based on information from NCHRP 1-61, Evaluation of Bonded Concrete Overlays on Asphalt Pavements. Also included are Case Histories 16 and 17 describing unbonded continuously reinforced concrete overlays on concrete. A listing of the 17 case histories is provided in Table 1. States where case history overlays were constructed are shaded in Figure 8.

Table 1. Listing of case history projects

Case History #	State	Route	Year Constructed	Overlay Type	Functional Classification
1	OK	US-69	2001	Concrete on asphalt–bonded	Principal or minor arterial
2	MT	SR-16	2001	Concrete on asphalt–bonded	Major or minor collector
3	IL	CR-56	1974	Concrete on asphalt–unbonded	Local
4	CO	US-287	2001	Concrete on asphalt–unbonded	Principal or minor arterial
5	UT	SR-89/114	2001	Concrete on composite–bonded	Local
6	IA	SH-13	2002	Concrete on composite–bonded	Major or minor collector
7	IN	I-69	1986	Concrete on composite–unbonded	Interstate, freeway, expressway
8	OK	I-35	2004	Concrete on composite–unbonded	Interstate, freeway, expressway
9	IA	V-63	2002	Concrete on concrete–bonded	Local
10	IL	I-88	1996	Concrete on concrete–bonded	Interstate, freeway, expressway
11	MI	US-131	1998	Concrete on concrete–unbonded	Principal or minor arterial
12	NC	I-85	1998	Concrete on concrete–unbonded	Interstate, freeway, expressway
13	CO	SH-83	2005	Concrete on asphalt–bonded	Major or minor collector
14	LA	US-425	2003	Concrete on asphalt–bonded	Principal or minor arterial
15	PA	SR-119	2010	Concrete on asphalt–bonded	Local
16	CA	I-8	2017	Continuously reinforced concrete on concrete–unbonded	Interstate, freeway, expressway
17	AR	I-40	1988	Continuously reinforced concrete on concrete–unbonded	Interstate, freeway, expressway

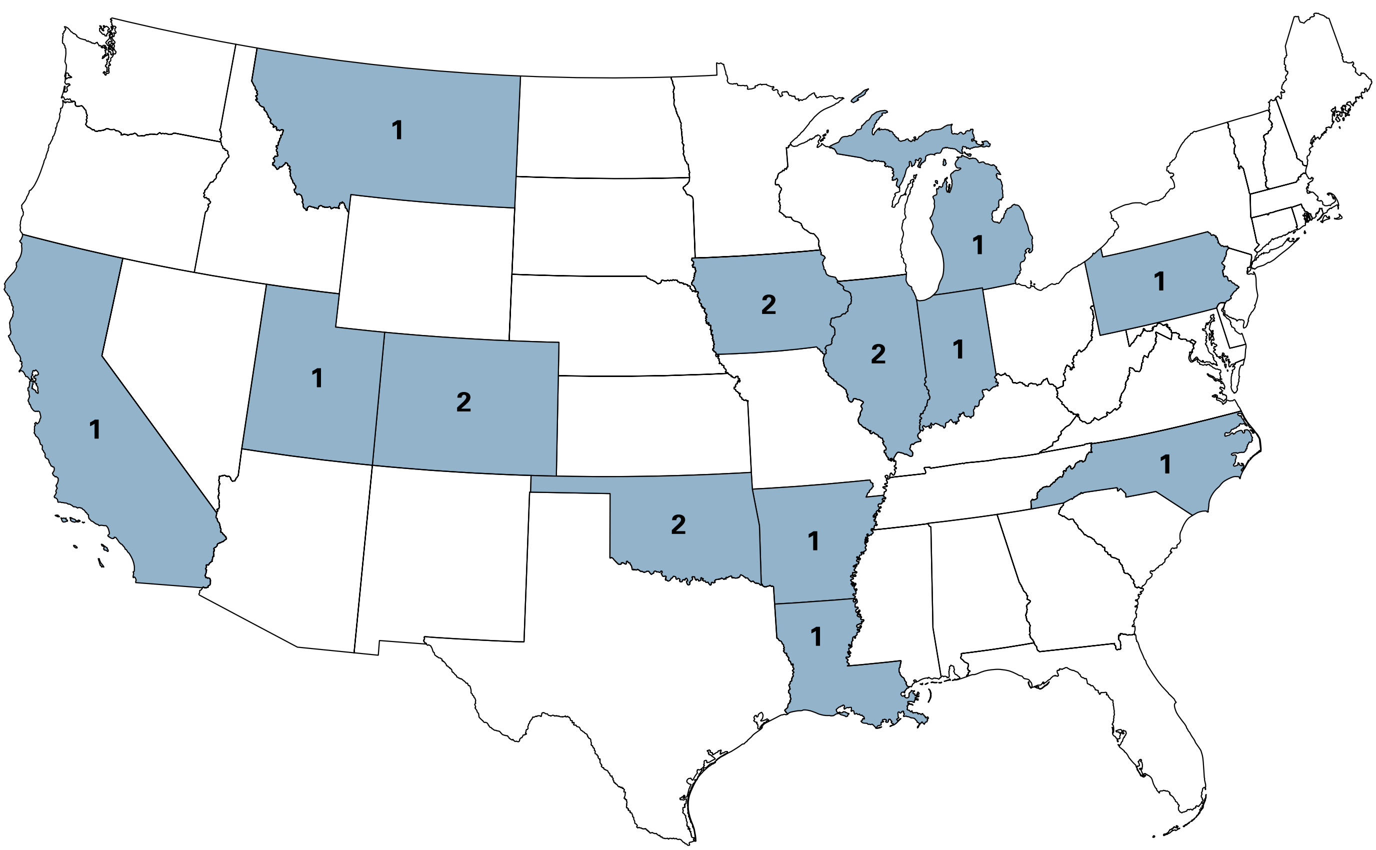

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Figure 8. States where case history overlays were constructed (shaded blue)

Case History #1

A concrete on asphalt–bonded (COA–B) overlay was constructed in 2001 on the southbound lanes of US-69 in Pittsburg County, Oklahoma. The project was approximately 1.5 miles long, and the overlay was designed to be 4 and 6 inches thick. Table 2 summarizes the design information.

This route serves as a primary freight corridor for trucks serving the Dallas/Ft. Worth metroplex from the north and east. The average daily traffic (ADT) in 2011 was 16,000 for two directional movements, with 30% trucks. The estimated equivalent single axle loads (ESALs) from 2001 through 2020 is 21,000,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing asphalt pavement had been experiencing stability issues (rutting and shoving), though there was no indication of stripped layers.

The overlay was constructed one lane at a time with traffic adjacent to the paving operation. Variable-depth pre-overlay milling was performed, and the profile grade was raised approximately 2 inches. No pre-overlay repairs were required. A typical cross section is shown in Figure 9.

Visible cracks and joint spalling at the centerline in 38 slabs (<1%) were observed in 2010. Few repairs have been necessary. Some bituminous patches have been placed, and minor cracking has been held tight by the macrofibers used in the overlay. Figure 10 and Figure 11 show the construction of the overlay in 2001 and its condition in 2020, respectively.

Table 2. Design information–Case History #1

Engineer	Oklahoma Department of Transportation
Owner	Oklahoma Department of Transportation
Overlay Joint Transverse Spacing	6 ft
Overlay Joint Longitudinal Spacing	6 ft and 7 ft (see typical cross section)
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	No
Overlay Joint Sealing	No
Subdrains	No
Existing Subbase Type	Granular
Design Details	Transverse joints sawed T/3 x ⅛ in. at 6 ft
Fibers (Used/Type/Dosage)	Macro – 3 lb/yd^3

Brent Burwell, ACPA, OK/AR Chapter, used with permission

Figure 10. Construction of overlay on US-69 in Pittsburg County, Oklahoma (2001)

Brent Burwell, ACPA, OK/AR Chapter, used with permission

Figure 11. US-69 in Pittsburg County, Oklahoma (2020)

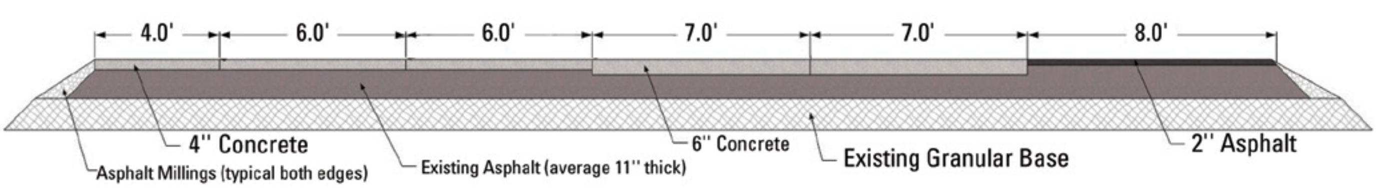

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Figure 9. Typical cross section–Case History #1

Case History #2

A COA–B overlay was constructed in 2001 on SR-16 in Dawson County, Montana, from the I-94 interchange south approximately 0.6 miles. The project was approximately 0.6 miles long, and the overlay was designed to be 4 inches thick. Table 3 summarizes the design information.

This is a three-lane urban section in an industrial area, with a grain terminal and truck stop along the route. The ADT in 2012 was 4,880 for two directional movements, with 15% trucks. The estimated ESALs from 2001 through 2020 is 4,300,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.4.

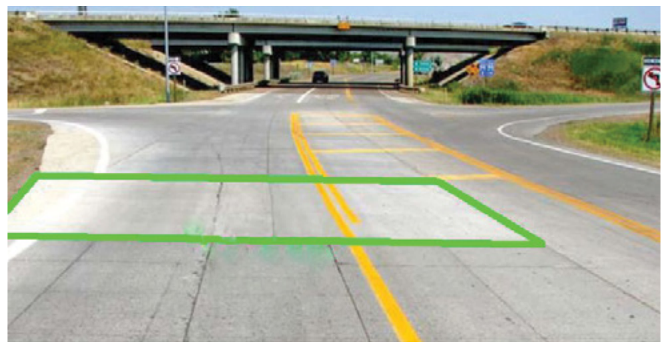
Table 3. Design information–Case History #2

Engineer	Montana Department of Transportation
Owner	Montana Department of Transportation
Overlay Joint Transverse Spacing	4 ft
Overlay Joint Longitudinal Spacing	4 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	No
Overlay Joint Sealing	No
Subdrains	No
Existing Subbase Type	Unknown
Design Details	Raised profile grade approx. 2½ in.
Fibers (Used/Type/Dosage)	Macro – 3 lb/yd^3

The existing asphalt pavement exhibited rutting, shoving, and thermal cracking.

The overlay was constructed while maintaining local access. Milling was performed (1½ inches), and some areas with insufficient asphalt remaining after milling were built up with new asphalt pavement (approximately 2 inches). A 4-inch bonded concrete overlay was then constructed. A typical cross section is shown in Figure 12.

Removal and full-depth repair of 15 panels (0.2%) was performed in 2005. Approximately 30 cracked panels (0.5%) were observed in 2008. Figure 13 and Figure 14 show the condition of the overlay in 2008 and 2020, respectively.



MTDOT 2008, used with permission

Figure 13. SR-16 near the I-94 interchange in Dawson County, Montana (June 2008), showing a repaired area (green box)

James Powell, ACPA, Northwest Chapter, used with permission

Figure 14. SR-16 near the I-94 interchange in Dawson County, Montana (June 2020)

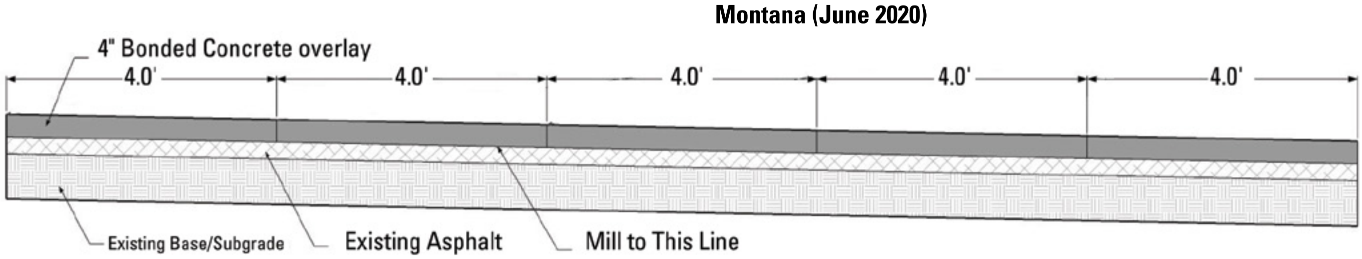


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Figure 12. Typical cross section–Case History #2

Case History #3

A COA–U overlay was constructed in 1974 on CR-56 in LaSalle County near Peru, Illinois. The project was approximately 2.8 miles long, and the overlay was designed to be 5 to 7 inches thick. Table 4 summarizes the design information.

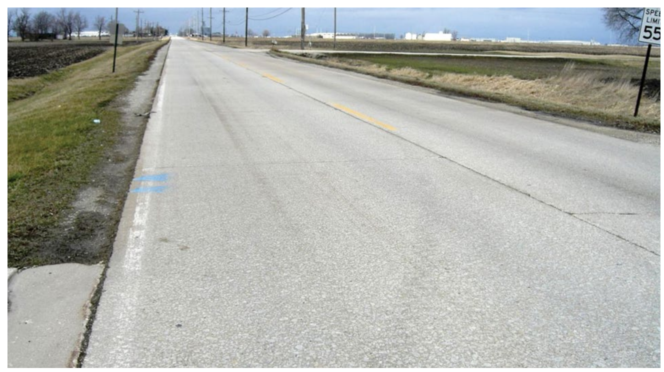
This is a two-lane local route providing access from I-80 to Peru, Illinois, with adjacent industrial facilities. The ADT in 2012 was 3,850 for two directional movements, with 30% trucks. The estimated ESALs from 1974 through 2020 is 12,500,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing 18-foot-wide asphalt pavement was widened to 24 feet. The overlay was constructed one lane at a time with local traffic adjacent to the paving operation. It is unknown whether any pre-overlay repairs were made. Contrary to current recommendations from the National Concrete Pavement Technology Center (CP Tech Center), no reinforcing or longitudinal joints were placed over the edges of the existing pavement. However, no longitudinal cracking occurred. A typical cross section is shown in Figure 15.

Faulting and minor cracking has been observed. The overlay was diamond ground after 28 years of service, and some patching was performed in the vicinity of a grain elevator. Figure 16 and Figure 17 show the condition of the overlay in 2012 and 2020, respectively.

Table 4. Design information–Case History #3

Engineer	LaSalle County, IL
Owner	LaSalle County, IL
Overlay Joint Transverse Spacing	15 ft, multiple options used
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Yes, at centerline joint
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	Granular
Design Details	Thickened widening section
Fibers (Used/Type/Dosage)	No



Randy Riley, ACPA, IL Chapter, used with permission

Figure 16. CR-56 near Peru, Illinois, after 38 years (2012)

Eric Ferrebee, ACPA, used with permission

Figure 17. CR-56 near Peru, Illinois, after 48 years (2020)

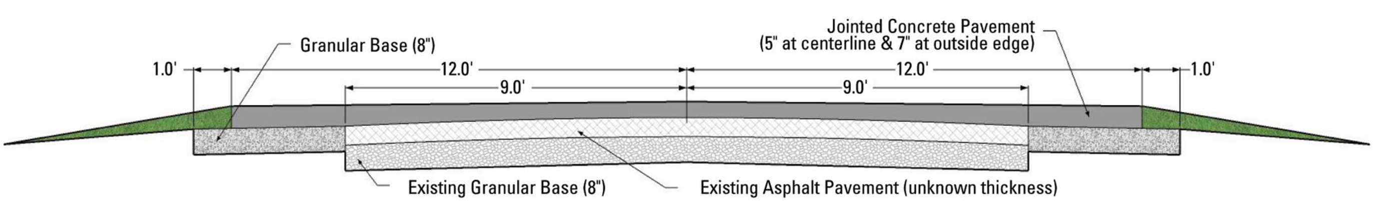


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Figure 15. Typical cross section–Case History #3

Case History #4

A COA-U overlay was constructed in 2001 on US-287 in Kiowa County, Colorado. The project was approximately 13.0 miles long, and the overlay was designed to be 10½ inches thick. Table 5 summarizes the design information.

US-287 is a part of the "Ports to Plains" freight corridor through Colorado, Oklahoma, and Texas. The ADT in 2011 was 2,400 for two directional movements, with 57% trucks, and the ADT in 2019 was 3,200 with 54.4% trucks. The estimated ESALs from 2001 through 2020 is 8,000,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.4.

This project was one of over 20 contracts utilizing concrete paving on this corridor. The existing 24-foot-wide mainline with 8-foot-wide shoulders consisted of a full-depth asphalt pavement and was overlaid with an unbonded concrete overlay. Minimal pre-overlay repairs were made, and the overlay was constructed under traffic utilizing a pilot car for alternating one-way traffic. The 13-mile project cost $12.6 million in 2001. A typical cross section is shown in Figure 18.

Isolated cracking has been observed in the southbound shoulder at one location based on 2012 imagery. Approximately 30 patches (0.3% of total panels) have been applied. Figure 19 and Figure 20 show the condition of the overlay in 2012 and 2020, respectively.

Table 5. Design information–Case History #4

Engineer	Colorado Department of Transportation
Owner	Colorado Department of Transportation
Overlay Joint Transverse Spacing	15 ft
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	Yes
Overlay Joint Tie Bars	Shoulders and centerline
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	Granular
Design Details	No pre-overlay milling; single-cut joints (0.188 in.), sealed with silicone
Fibers (Used/Type/Dosage)	No

Figure 19. US-287 in Kiowa County, Colorado, looking south (2012)

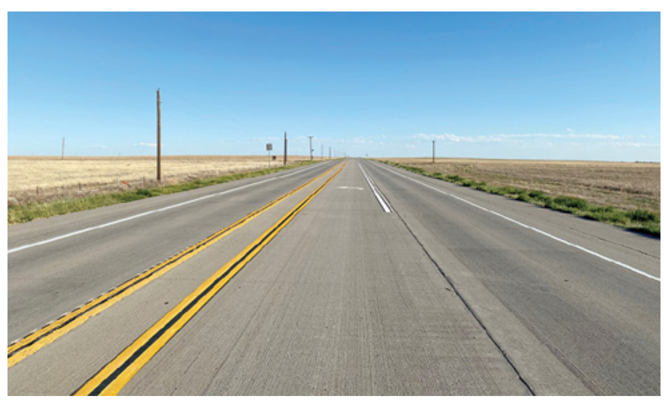

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Figure 20. US-287 with left turn lane in Kiowa County, Colorado, looking south (2020)

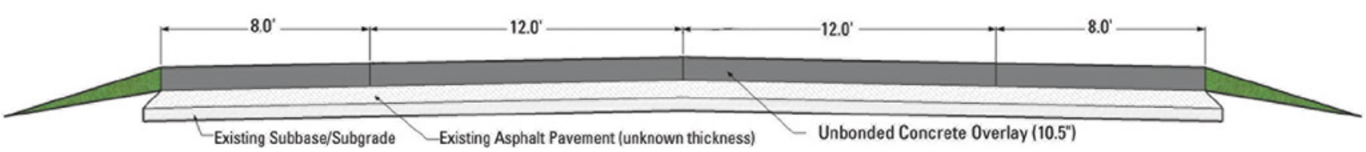

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Figure 18. Typical cross section–Case History #4

Case History #5

A bonded concrete overlay of composite pavement was constructed in 2001 on US-89 at SR-114 in Provo, Utah. The project was approximately 0.1 miles long, and the overlay was designed to be 4 inches thick. Table 6 summarizes the design information.

This is an urban section of US-89 in the central business district of Provo, Utah, approximately 1 mile east of I-15. The ADT in 2012 was 19,265 for two directional movements, with 22% trucks. The estimated ESALs from 2001 through 2020 is 12,400,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 50% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The original 18-foot-wide concrete pavement built in the early 1900s had been overlaid with asphalt numerous times and widened with full-depth asphalt. For the concrete overlay constructed in 2001, no pre-overlay repairs were made, and construction occurred on weekends. A typical cross section is shown in Figure 21.

Table 6. Design information–Case History #5

Engineer	Utah Department of Transportation Region 3
Owner	Utah Department of Transportation
Overlay Joint Transverse Spacing	4 ft
Overlay Joint Longitudinal Spacing	4 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	No
Overlay Joint Sealing	No
Subdrains	No
Existing Subbase Type	Unknown
Design Details	Variable-depth milling used to maintain the existing gutter profile
Fibers (Used/Type/Dosage)	Macro – 3 lb/yd^3

After the 2001 concrete overlay was placed, early cracking around utility structures and ultimately corner and longitudinal cracking caused by repetitive truck loading was observed. A few individual panels around utility structures were replaced early in the life of the project. Originally designed for 10 years, the 2001 concrete overlay was replaced after 11 years by a full-depth concrete section in 2012 to provide for additional capacity. Figure 22 and Figure 23 show the condition of US-89 before the 2001 concrete overlay was placed and in 2020, respectively.

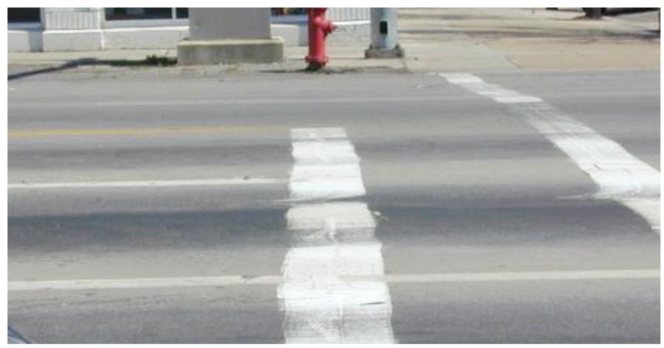

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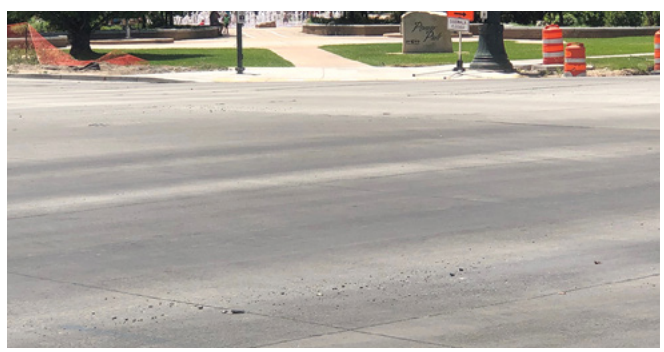
Figure 22. Rutted asphalt on US-89 in Provo, Utah, prior to concrete overlay (before 2001)



Mitzi McIntyre, CTS Cement, used with permission

Figure 23. US-89 in Provo, Utah (2020)

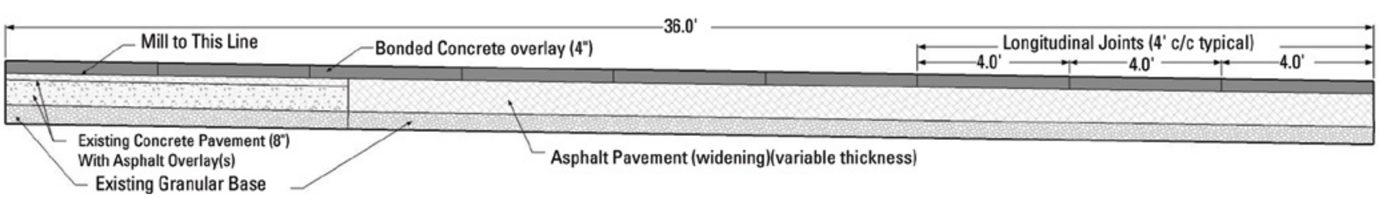


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Figure 21. Typical cross section–Case History #5

Case History #6

A bonded concrete overlay of composite pavement was constructed in 2002 on SH-13 approximately 9.6 miles north of Manchester, Iowa, between sections 51+00 to 208+00. The project was approximately 9.6 miles long, and the overlay was nominally designed to be 4 inches thick. Table 7 summarizes the design information.

This is a rural farm-to-market roadway in Delaware County, Iowa. The ADT in 2002 was 2,930 for two directional movements, with 11% trucks. The estimated ESALs from 2002 through 2020 is 1,800,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The original concrete pavement was constructed in 1931. It was overlaid with 2 inches of asphalt in 1964 and widened from 18 feet to 24 feet and overlaid again with 3 inches of asphalt in 1984. Approximately ¼ of an inch of asphalt was milled prior to construction of the concrete overlay, and the milled surface was sprayed with water when temperatures exceeded 100°F.

Although designed as an unbonded overlay on composite pavement, SH-13 between sections 51+00 and 208+00 is included in this technical brief as an example of a bonded overlay based on the construction methods used and follow-up studies, which showed significant bonding to the existing asphalt overlay. A typical cross section is shown in Figure 24.

Since the overlay was placed, longitudinal cracking, primarily attributed to tooled joints, has been observed. The International Roughness Index (IRI) value of the overlay surface as of 2018 was 177 inches per mile. Repairs have included panel patching. Figure 25 and Figure 26 show the condition of the overlay in 2014 and 2020, respectively.

Table 7. Design information–Case History #6

Engineer	Iowa Department of Transportation
Owner	Iowa Department of Transportation
Overlay Joint Transverse Spacing	Multiple options used
Overlay Joint Longitudinal Spacing	Multiple options used
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	No
Overlay Joint Sealing	Yes, stapled over widening units
Subdrains	Partial extents
Existing Subbase Type	Natural subgrade
Design Details	Widened section with thickened edges; multiple research sections incorporated into this project
Fibers (Used/Type/ Dosage)	Monofilament – 1 lb/yd^3 Fibrillated – 3 lb/yd^3 Structural – 3 lb/yd^3

Dan King, CP Tech Center

Figure 25. SH-13 bonded overlay north of Manchester, Iowa (2014)

Dan King, CP Tech Center

Figure 26. SH-13 bonded overlay north of Manchester, Iowa (2020)

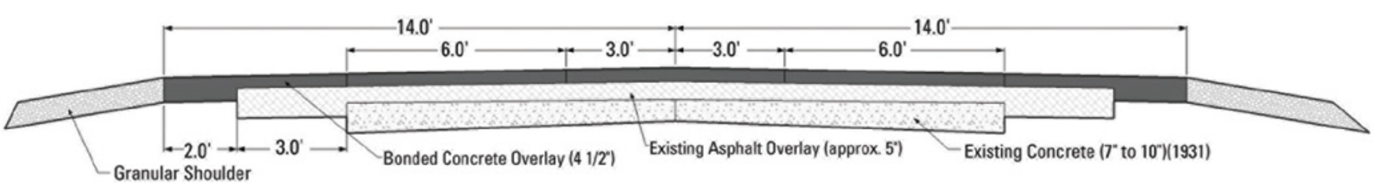

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Figure 24. Typical cross section–Case History #6

Case History #7

An unbonded concrete overlay of composite pavement was constructed in 1986 on I-69 north of SR-18 in Grant County, Indiana. The project was approximately 4.6 miles long, and the overlay was designed to be 11 inches thick. Table 8 summarizes the design information.

I-69 is a major freight corridor connecting Indianapolis to I-80 and I-94 to the north. The ADT in 2013 was 26,000 for two directional movements, with an estimated 42% trucks. The estimated ESALs from 1986 through 2020 is 70,500,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing concrete pavement suffered from D-cracking and had been overlaid with asphalt. The existing asphalt overlay was milled from a constant cross slope to a crowned section, and a new 1-inch-thick asphalt interlayer was placed prior to constructing the concrete overlay. Minimal pre-overlay repairs were performed. A typical cross section is shown in Figure 27.

Based on imagery from 2012 and 2013, mid-panel, longitudinal, and/or corner cracking has been observed in approximately 2% of panels. Full-depth patching has been performed on approximately 6% of panels, and diamond grinding was performed in 2005 after 19 years in service. Due to the success of the original overlay, some areas were reconstructed as an overlay in 2019. Figure 28 and Figure 29 show the condition of the overlay in 2005 and 2019, respectively.

Table 8. Design information–Case History #7

Engineer	Indiana Department of Transportation
Owner	Indiana Department of Transportation
Overlay Joint Transverse Spacing	Random (average 15 ft)
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Yes, at centerline joint
Overlay Joint Sealing	Yes
Subdrains	Yes, geocomposite
Existing Subbase Type	Granular
Design Details	1 in. HMA interlayer placed over milled asphalt overlay (existing)
Fibers (Used/Type/Dosage)	No

Patrick Long, IRMCA, on behalf of ACPA, IN Chapter, used with permission

Figure 28. I-69 in Grant County, Indiana, after grinding (2005)

Austin Rumsey, Primco, Inc., used with permission

Figure 29. I-69 in Grant County, Indiana (2019)

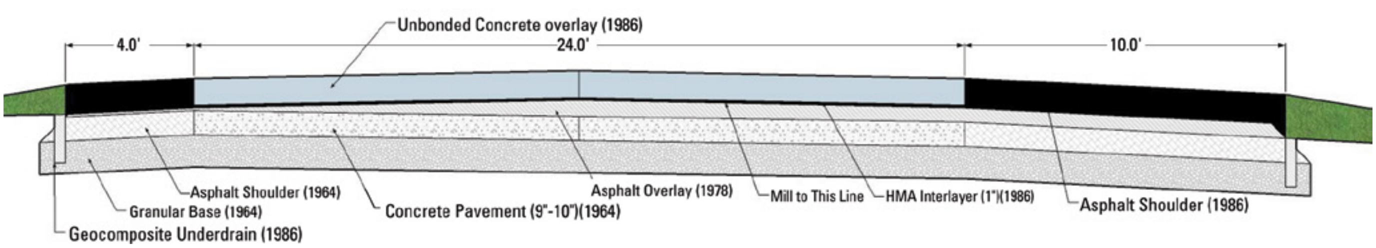

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Figure 27. Typical cross section–Case History #7

Case History #8

An unbonded concrete overlay of composite pavement was constructed in 2004 on I-35 in Love County, Oklahoma, seven miles north of the Texas State line. The project was approximately 3.5 miles long, and the overlay was designed to be 11½ inches thick. Table 9 summarizes the design information.

I-35 is a major freight corridor connecting Oklahoma City, Oklahoma, and Dallas, Texas. The ADT in 2011 was 28,400 for two directional movements, with an estimated 41% trucks. The estimated ESALs from 2004 through 2020 is 38,600,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing concrete pavement had been overlaid with approximately 4 inches of asphalt. Two inches of asphalt were milled, and the remaining served as an interlayer between the new concrete overlay and the existing jointed plain concrete pavement (JPCP). For pre-overlay repairs, the plan quantity included 50 square yards of full-depth patching. The asphalt shoulder on the southbound lanes was reconstructed prior to overlay placement to maintain traffic. A typical cross section is shown in Figure 30.

No distresses have been observed and no repairs have been made to date. Figure 31 and Figure 32 show the condition of the overlay in 2014 and 2020, respectively.

Table 9. Design information–Case History #8

Engineer	Oklahoma Department of Transportation
Owner	Oklahoma Department of Transportation
Overlay Joint Transverse Spacing	15 ft
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	Yes
Overlay Joint Tie Bars	Yes, centerline and shoulders
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	Unknown
Design Details	Cross slopes were changed from 1.5% (existing) to 2.0% (new) during the milling operation
Fibers (Used/Type/Dosage)	No
Observed Distress(es)	None
Repairs to Date	None

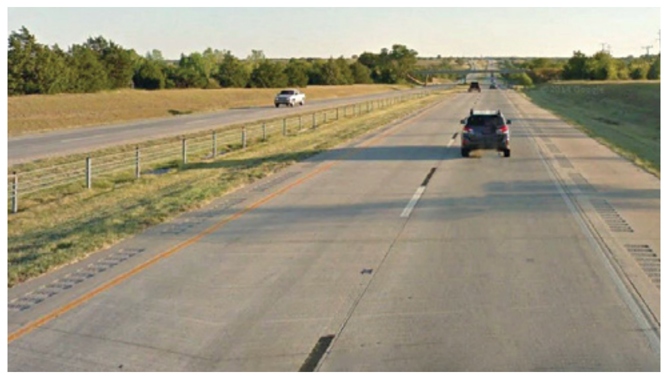

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Figure 31. I-35 in Love County, Oklahoma, looking north (2014)

Brent Burwell, ACPA, OK/AR Chapter, used with permission

Figure 32. I-35 in Love County, Oklahoma, looking north (2020)

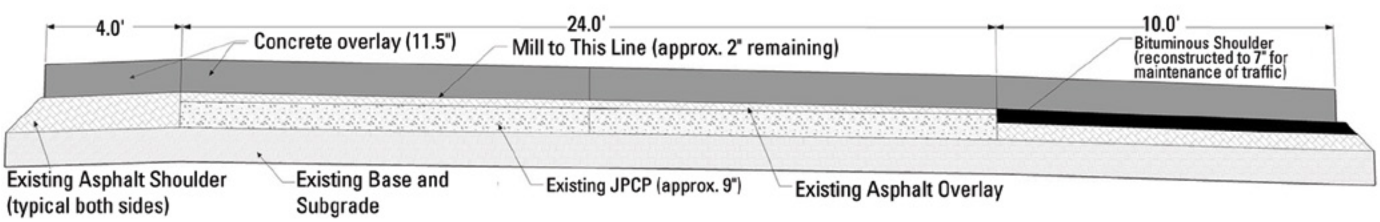

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Figure 30. Typical cross section–Case History #8

Case History #9

A concrete on concrete–bonded (COC–B) overlay was constructed in 2002 on V-63 in Jefferson County, Iowa. The project was approximately 5.1 miles long, and the overlay was designed to be 4 inches thick. Table 10 summarizes the design information.

V-63 is local farm-to-market county route in southern Iowa. The ADT in 2010 was 1,160 for two directional movements, with an estimated 5% trucks. The estimated ESALs from 2002 through 2020 is 300,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing concrete pavement was shotblasted and overlaid with 4 inches of concrete. The transverse joints were sawed full depth plus ½ an inch, and the centerline joint was not sawed but allowed to reflect through from the underlying pavement. Pre-overlay repairs were minimal. A typical cross section is shown in Figure 33.

Since the overlay was placed, material-related distress, joint shadowing, and joint distress have been observed. The IRI value of the overlay surface in 2017 was 108 inches per mile. Crack sealing and patching have been performed. Figure 34 and Figure 35 show the condition of the overlay in 2014 and 2020, respectively.

Table 10. Design information–Case History #9

Engineer	Jefferson County
Owner	Jefferson County
Overlay Joint Transverse Spacing	20 ft
Overlay Joint Longitudinal Spacing	11 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Over widened section
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	Unknown; either granular or natural subgrade
Design Details	Northernmost mile widened integrally with the overlay; tie bar placed over the existing pavement, but no joint sawn
Fibers (Used/Type/Dosage)	No

Iowa Concrete Paving Association, used with permission

Figure 34. V-63 in Jefferson County, Iowa (2014)

Dan King, CP Tech Center

Figure 35. V-63 in Jefferson County, Iowa (2020)

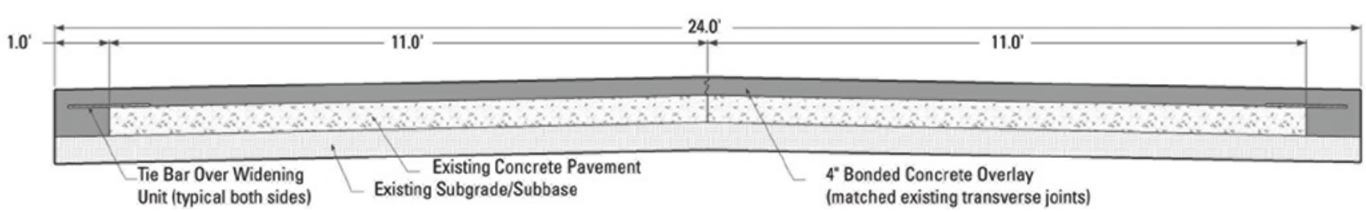

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Figure 33. Typical cross section–Case History #9

Case History #10

A COC–B overlay was constructed in 1996 on I-88 in Whiteside County, Illinois. The project was approximately 3.1 miles long, and the overlay was designed to be 3 inches thick. Table 11 summarizes the design information.

I-88 is a major east-west route from Chicago, Illinois, to the Quad Cities. The ADT in 2013 was 16,800 for two directional movements, with an estimated 24% trucks. The estimated ESALs from 1996 through 2020 is 24,800,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

The existing 8-inch-thick continuously reinforced concrete pavement (CRCP) was milled and shotblasted prior to placement of the 3-inch-thick unreinforced bonded concrete overlay. Pre-overlay repairs were minimal. A typical cross section is shown in Figure 36.

Since the overlay was placed, debonding and subsequent structural failure has been observed at a few isolated locations. Twenty-five full-depth patches (0.5% of total panels) have been applied. Figure 37 and Figure 38 show the condition of the overlay in 2011 and 2020, respectively.

Table 11. Design information–Case History #10

Engineer	Illinois Department of Transportation
Owner	Illinois Department of Transportation
Overlay Joint Transverse Spacing	None (continuously reinforced)
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	No
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	4 in. stabilized
Design Details	Asphalt shoulders
Fibers (Used/Type/Dosage)	No
Observed Distress(es)	—
Repairs to Date	25 (0.5%) full-depth patches

Randy Riley, ACPA, IL Chapter, used with permission

Figure 37. Eastbound I-88 in Whiteside County, Illinois, looking west (2011)

Eric Ferrebee, ACPA, used with permission

Figure 38. I-88 in Whiteside County, Illinois (2020)

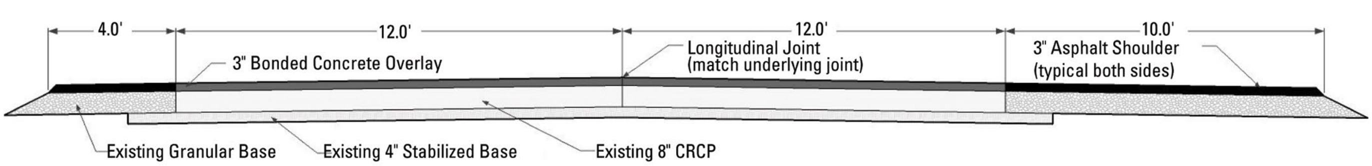

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Figure 36. Typical cross section–Case History #10

Case History #11

A COC–U overlay was constructed in 1998 on the southbound lanes of US-131 in Allegan County, Michigan. The project was approximately 4.0 miles long, and the overlay was designed to be ±7 inches thick. Table 12 summarizes the design information.

US-131 is a primary north-south route in western Michigan connecting to I-94 and I-80 to the south. The ADT in 2013 was 29,600 for two directional movements, with an estimated 10% trucks. The estimated ESALs from 1998 through 2020 is 13,800,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

Table 12. Design information–Case History #11

Engineer	Michigan Department of Transportation
Owner	Michigan Department of Transportation
Overlay Joint Transverse Spacing	13 ft
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	Yes
Overlay Joint Tie Bars	Yes (centerline and shoulders)
Overlay Joint Sealing	Yes
Subdrains	No
Existing Subbase Type	4 in. clean granular on 14 in. sand
Design Details	Tied concrete shoulders provide additional edge support; 40% GGBFS in the concrete mixture
Fibers (Used/Type/Dosage)	No

The original pavement was a jointed reinforced concrete pavement (JRCP) constructed in the early 1960s with transverse joints at a spacing of 99 feet. The concrete overlay was constructed with a 1-inch-thick dense-graded asphalt interlayer (the Michigan Department of Transportation now has a specification for a drainable asphalt interlayer), and a crown correction was made with variable-thickness concrete. No pre-overlay repairs were performed, and construction took place adjacent to traffic. Tied concrete shoulders combined with sandy soils have proven adequate for support. A typical cross section is shown in Figure 39.

Since the overlay was placed, a 0.8-mile-long section of the northbound inside lane was observed to be experiencing early joint deterioration. Repairs have included 18 patches (0.3% of total panels) and the sealing of 24 cracked slabs (0.4%). Figure 40 and Figure 41 show the condition of the overlay in 2012 and 2020, respectively.

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Figure 40. US-131 in Allegan County, Michigan (2012)

Daniel DeGraaf, Michigan Concrete Association, used with permission

Figure 41. US-131 in Allegan County, Michigan (2020)

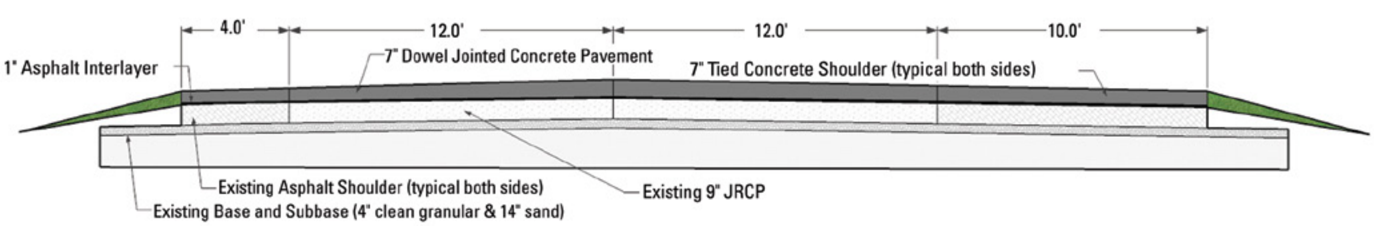

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Figure 39. Typical cross section–Case History #11

Case History #12

A COC–U overlay was constructed over three projects between 1997 and 2001 on I-85 in Granville County, North Carolina. The projects were approximately 17.3 miles long in total, and the overlay was designed to be 10 inches thick. Table 13 summarizes the design information.

This section of I-85 is a major freight corridor from Raleigh-Durham, North Carolina, north to Richmond, Virginia. The ADT in 2012 was 29,000 for two directional movements, with an estimated 25% trucks. The estimated ESALs from 1998 through 2020 is 25,500,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 75% of the traffic in one direction in the design lane, and a truck factor of 1.4.

Table 13. Design information–Case History #12

Engineer	North Carolina Department of Transportation
Owner	North Carolina Department of Transportation
Overlay Joint Transverse Spacing	Average 20 ft (variable 18, 19, 20, and 21 ft)
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	Yes
Overlay Joint Tie Bars	Yes (centerline joint)
Overlay Joint Sealing	Yes
Subdrains	Yes
Existing Subbase Type	Unknown
Design Details	Design thickness nominally 1 in. thinner than the reconstruction alternative typically used in North Carolina
Fibers (Used/Type/Dosage)	No

The original pavement was an 8-inch-thick CRCP constructed in the 1970s that was experiencing punchouts and longitudinal cracking. Two of the 10-inch unbonded concrete overlay sections were constructed with a 2-inch-thick dense-graded asphalt interlayer, and the third utilized a 2-inch-thick permeable asphalt interlayer. Two of the projects were constructed adjacent to traffic, and the third was paved 24 feet wide. Pre-overlay repairs were minimal. A typical cross section is shown in Figure 42.

Since the overlay was placed, mid-panel cracking has been observed in 1.5% of slabs, and 98% of those cracked slabs were constructed during the first project in 1997. Repairs have included full-depth patching (on 0.2% of slabs) and crack sealing. Figure 43 and Figure 44 show the condition of the overlay in 2013 and 2020, respectively.

Greg Dean, Carolinas Concrete Paving Association, used with permission

Figure 43. I-85 in Granville County, North Carolina (2013)

Greg Dean, Carolinas Concrete Paving Association, used with permission

Figure 44. I-85 in Granville County, North Carolina (2020)

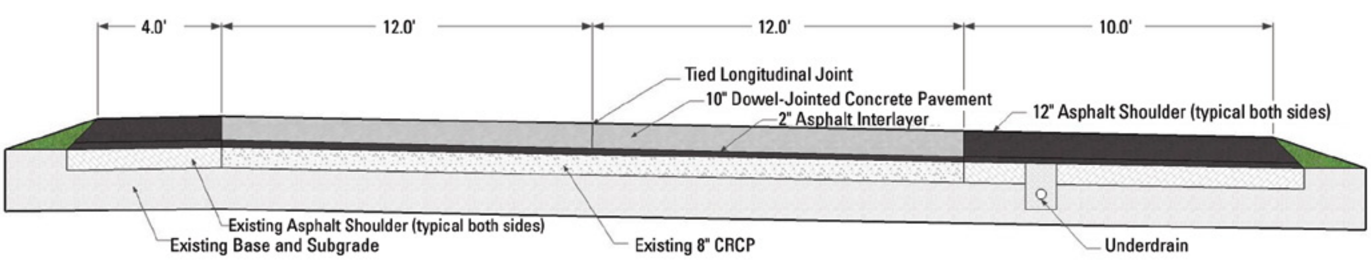

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Figure 42. Typical cross section–Case History #12

Case History #13

A COA–B overlay was constructed in 2005 on SH-83 between Lewiston Way and Orchard Road in Arapahoe County, Colorado. The project was approximately 1.6 miles long, and the overlay was nominally designed to be 6 inches thick. Table 14 summarizes the design information.

This section of SH-83 is an urban, six-lane, secondary highway near Foxfield, Colorado, in Arapahoe County. The ADT in 2001 was 52,024 for two directional movements, with an estimated 4.7% trucks. The estimated ESALs from 2005 through 2019 is 21,300,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.5.

Table 14. Design information–Case History #13

Engineer	Colorado Department of Transportation
Owner	Colorado Department of Transportation
Overlay Joint Transverse Spacing	6 ft
Overlay Joint Longitudinal Spacing	6 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Yes
Overlay Joint Sealing	Yes (3/16 in. sawcut)
Subdrains	Not applicable
Existing Subbase Type	Natural subgrade
Design Details	Overlay thickness determined through a whitetopping design method used by the Colorado Department of Transportation and a 10-year design life
Fibers (Used/Type/Dosage)	None

The existing asphalt pavement consisted of 5 to 9 inches of asphalt over an aggregate base. Approximately ¾ of an inch of asphalt was milled prior to placement of the concrete overlay. The milled surface was cleaned with high-pressure air and power-broomed immediately ahead of the paver. Additionally, minimal patching was performed before overlay placement. A typical cross section is shown in Figure 45.

Since the overlay was placed, cracking has been observed in fewer than 1% of slabs, though map cracking is present, and faulting of less than 0.06 inches has been observed. The average IRI value of the overlay surface was 140 inches per mile. Less than 80 square feet of concrete patching has been performed. Figure 46 and Figure 47 show the condition of the overlay in the southbound lanes of SH-83 and an example of minimal spalling, respectively, in 2018.

Linda Pierce, NCE, used with permission

Figure 46. Southbound lanes of SH-83 in Arapahoe County, Colorado, looking north (2018)

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Figure 47. Minimal spalling at slab corner on SH-83 in Arapahoe County, Colorado (2018)

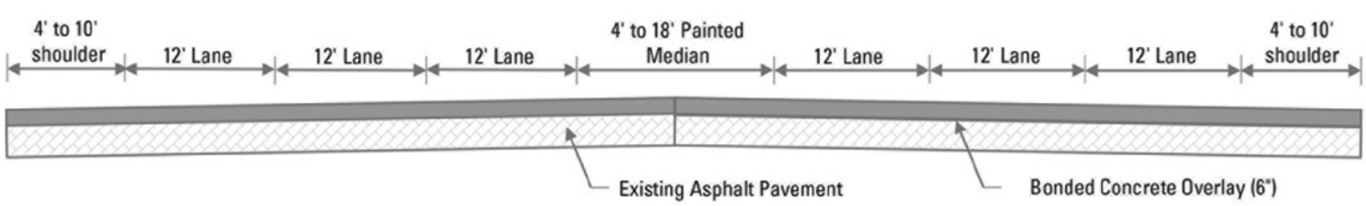

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Figure 45. Typical cross section–Case History #13

Case History #14

A COA–B overlay was constructed in 2003 on US-425 between Field Road and Carroll Lake Bridge near Ferriday, Louisiana (northbound lanes only). The project was approximately 1.7 miles long, and the overlay was nominally designed to be 4 inches thick. Table 15 summarizes the design information.

This section of US-425 is a four-lane divided highway in the vicinity of Ferriday, Louisiana. The ADT in 2003 was 7,900 for two directional movements, with an estimated 14% trucks. The estimated ESALs from 2003 through 2019 is 5,200,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.5.

The existing pavement consisted of 2 to 10 inches of asphalt overlay over an unknown thickness of concrete pavement. A condition assessment prior to placement of the concrete overlay indicated significant patching (approximately 55,000 square feet) and an IRI value of approximately 180 inches per mile. Pre-overlay repairs included pavement patching and 2 to 4 inches of cold milling. Curing compound was applied at 1.5 gallons per 100 square feet. A typical cross section is shown in Figure 48.

Since the overlay was placed, cracking has been observed in fewer than 1% of slabs and faulting of less than 0.3 inches has been observed. The average IRI value of the overlay surface was 150 inches per mile. Less than 10 square feet of patching has been performed. Figure 49 and Figure 50 show the condition of the overlay and the typical joint condition, respectively, in 2019.

Table 15. Design information–Case History #14

Engineer	Louisiana Department of Transportation and Development
Owner	Louisiana Department of Transportation and Development
Overlay Joint Transverse Spacing	4 ft
Overlay Joint Longitudinal Spacing	4 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Yes
Overlay Joint Sealing	No (⅛ in. to ¼ in. wide sawcut)
Subdrains	Not applicable
Existing Subbase Type	Natural subgrade
Design Details	Thickness design method unknown, 20-year design life
Fibers (Used/Type/Dosage)	ASTM C1116 (Type III) – 3 lb/yd^3

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Figure 49. US-425 near Ferriday, Louisiana, looking north (2019)

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Figure 50. Typical joint condition on US-425 near Ferriday, Louisiana (2019)

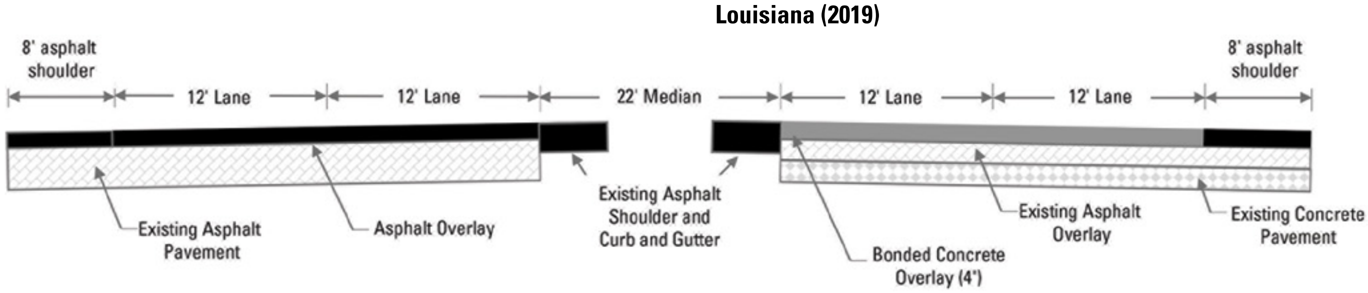

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Figure 48. Typical cross section–Case History #14

Case History #15

A COA–B overlay was constructed in 2010 on SR-119 between Eberly Way and Bell Drive near Uniontown, Pennsylvania. The project was approximately 3.9 miles long, and the overlay was nominally designed to be 6 inches thick. Table 16 summarizes the design information.

This section of SR-119 is a five-lane urban highway located in the vicinity of Uniontown, Pennsylvania. The ADT in 2009 was 9,983 for two directional movements, with 7% trucks. The estimated ESALs from 2010 through 2019 is 3,700,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.5.

The existing asphalt pavement was originally constructed in 1947 and widened in 1955 and consisted of 7.5 to 10 inches of asphalt over 12 inches of crushed aggregate base and 6 inches of a special subbase. Approximately 3.5 to 4.5 inches of the existing asphalt pavement profile were milled prior to placement of the concrete overlay, and cracks greater than ¾ of an inch wide were cleaned and filled. Early-entry sawing seemed to prevent random cracking in the overlay. A typical cross section is shown in Figure 51.

Since the overlay was placed, cracking has been observed in fewer than 15% of slabs and faulting of less than 0.4 inches has been observed. The average IRI value of the overlay surface was 100 inches per mile. Less than 210 square feet of concrete patching has been performed. Figure 52 and Figure 53 show the condition of the overlay in the southbound lanes of SR-119 and the typical slab condition, respectively, in 2019.

Table 16. Design information–Case History #15

Engineer	Pennsylvania Department of Transportation
Owner	Pennsylvania Department of Transportation
Overlay Joint Transverse Spacing	6 ft
Overlay Joint Longitudinal Spacing	6 ft
Overlay Joint Dowel Bars	No
Overlay Joint Tie Bars	Yes
Overlay Joint Sealing	Yes (⅛ in. sawcut)
Subdrains	Not applicable
Existing Subbase Type	Special subbase (6 in.)
Design Details	Overlay thickness determined using BCOA-ME
Fibers (Used/Type/Dosage)	None

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Figure 52. Southbound lanes of SR-119 near Uniontown, Pennsylvania, looking north (2019)

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Figure 53. Typical slab condition on SR-119 near Uniontown, Pennsylvania, looking south (2019)

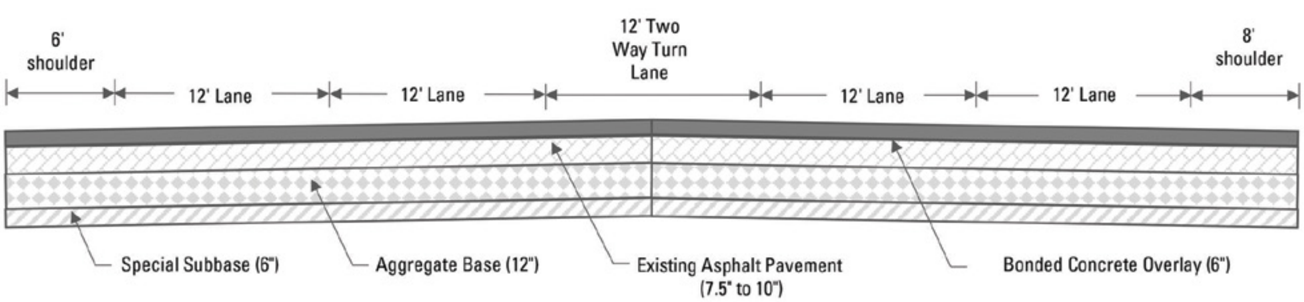

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Figure 51. Typical cross section–Case History #15

Case History #16

A continuously reinforced concrete overlay of existing jointed plain concrete pavement was constructed in 2017 on I-8 between Ogilby Road OC and the SR-186/I-8 separation near El Centro, California. The project was approximately 6.9 miles long, and the overlay was nominally designed to be 9 inches thick. Table 17 summarizes the design information.

This section of I-8 is a rural, four-lane, divided Interstate highway near El Centro, California. The ADT in 2016 was 7,470 for two directional movements, with 52% trucks. The estimated ESALs from 2017 through 2020 is 6,900,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.5. The estimated 20-year design ESALs is 53,500,000.

The existing pavement consisted of 8.4 inches of jointed plain concrete pavement over 5.4 inches of cement-treated base over 3 inches of aggregate base over 6 inches of aggregate subbase. Prior to placement of the concrete overlay, areas of spalling were repaired and deteriorated slabs were replaced, and curing compound was applied to the panel replacements. A 2.4-inch asphalt separation layer was constructed, and some grinding was performed after the overlay was completed to meet California Department of Transportation (Caltrans) state specifications for smoothness. A typical cross section is shown in Figure 54.

The overlay has been in good condition overall since placement, with no repairs performed to date. Figure 55 and Figure 56 show placement of the overlay in 2017 and the condition of the overlay in 2020, respectively.

Table 17. Design information–Case History #16

Engineer	Caltrans
Owner	Caltrans
Overlay Joint Transverse Spacing	Not applicable
Overlay Joint Longitudinal Spacing	12 ft
Overlay Joint Dowel Bars	Not applicable
Overlay Joint Tie Bars	At construction joints
Overlay Joint Sealing	Not applicable
Subdrains	Not applicable
Existing Subbase Type	Natural subgrade
Design Details	Steel: 0.55% to 0.70%, Grade 60, No. 6 steel bars spaced 5.5 to 8.0 in.; concrete placed using a two-paver system
Fibers (Used/Type/Dosage)	Not applicable

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Figure 55. Concrete placement on I-8 near El Centro, California (2017)

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Figure 56. Typical condition of I-8 near El Centro, California (2020)

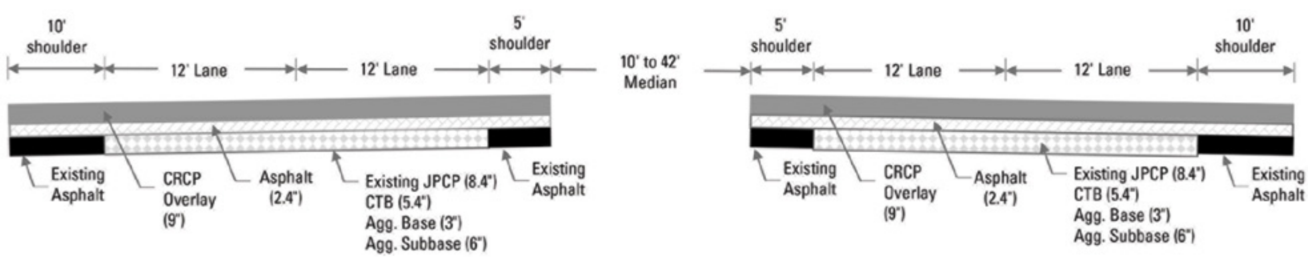

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Figure 54. Typical cross section–Case History #16

Case History #17

A continuously reinforced concrete overlay of existing jointed plain concrete pavement was constructed in 1988 on I-40 in North Little Rock, Arkansas. The project was approximately 2.9 miles long, and the overlay was nominally designed to be 6 inches thick. Table 18 summarizes the design information.

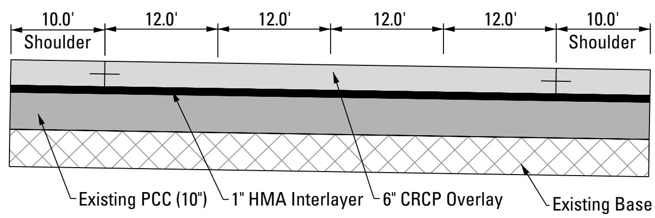
This section of I-40 is a four-lane Interstate highway that runs through the Dark Hollow neighborhood in North Little Rock, Arkansas. The annual average daily traffic (AADT) in 2018 was 131,000 vehicles per day in both directions, with 6% trucks. The estimated ESALs from 1988 through 2021 is 23,700,000, assuming a traffic growth rate of 2% with a 50/50 directional traffic split, 100% of the traffic in one direction in the design lane, and a truck factor of 1.3.

As part of the 1988 rehabilitation, a fourth lane was added to the three existing travel lanes in each direction, and new 10-foot-wide and 10-inch-thick concrete shoulders were constructed on either side of the travel lanes in each direction to replace the existing asphalt shoulders. The total width of the overlay in each direction was 69 feet 4 inches, which includes 68 feet for the four travel lanes and two shoulders plus a width of 1 foot 4 inches under the median barrier. A 1-inch-thick asphalt concrete interlayer was placed between the existing JPCP and the CRCP overlay. The new concrete shoulders were tied to the existing JPCP lanes using 24-inch-long No. 5 bars spaced at 30 inches, and a 6-foot-wide portion of each outside shoulder was placed over a granular base. A typical cross section is shown in Figure 57..

In recent years, the overlay has required repairs to treat spalling at crack and transverse construction joint locations, and several full-depth patches have been applied to repair punchout areas. However, in 2018 falling weight deflectometer (FWD) testing indicated low mid-slab deflections, indicating good overall support under the CRCP overlay. Figure 58 shows the condition of the CRCP overlay on eastbound I-40, and Figure 59 shows the full-depth patch areas on eastbound I-40.

Table 18. Design information–Case History #17

Engineer	Arkansas Department of Transportation
Owner	Arkansas Department of Transportation
Overlay Joint Transverse Spacing	Not applicable
Overlay Joint Longitudinal Spacing	12 ft wide (four 12 ft wide lanes and two 10 ft wide shoulders)
Overlay Joint Dowel Bars	Not applicable
Overlay Joint Tie Bars	No. 4 bars at 30 in. spacing
Overlay Joint Sealing	Not applicable
Subdrains	Not applicable
Existing Subbase Type	Natural subgrade
Design Details	Longitudinal steel: 0.6 % (No. 4 bars at 5.4 in. spacing) with 16 in. bar lap splice; Transverse steel: No. 4 bars at 30 in. spacing; End terminals: W 58 x 12 wide-flange beam expansion joints; compressive strength 3,000 lb/in.^{3} at 28 days
Fibers (Used/Type/Dosage)	Not used



Snyder & Associates, Inc., used with permission

Figure 57. Typical cross section–Case History #17

FHWA, Arkansas Division Office

Figure 58. Eastbound I-40 (2019)

FHWA, Arkansas Division Office

Figure 59. Full-depth patches on eastbound I-40

Additional Resources

The following documents and other resources provide in-depth information on the design and construction of concrete overlays and are available on the CP Tech Center's website, https://cptechcenter.org.

Guide to Concrete Overlays (4th edition) (Fick et al. 2021). The purpose of the guide is to fill the knowledge gap among practitioners about concrete overlays so that pavement owners can confidently include concrete overlays in their toolbox of pavement solutions and make more informed decisions about their design and construction. Another goal for the guide is to help owner agencies understand and appreciate the versatility of concrete overlay solutions.

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

Concrete Overlay Field Application Program Final Report: Volume I (Fick and Harrington 2012). The CP Tech Center 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. This report outlines the results of the field application program and the key lessons learned.

Concrete Overlay Field Application Program – Iowa Task Report: US 18 Concrete Overlay Construction Under Traffic (Cable 2012). The CP Tech Center, Iowa Department of Transportation, and Federal Highway Administration (FHWA) 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. This report documents the planning, design, and construction of an 18.82-mile project in northeast Iowa and lessons learned.

National Concrete Overlay Explorer (ACPA 2020). This online database (http://overlays.acpa.org/webapps/overlayexplorer/index.html) provides information about concrete overlay projects in the United States and Canada since 1900 in three formats: map view (which shows the locations of all projects on an interactive map), table view (which lists the type of overlay and specific application, State, year constructed, and overlay thickness for each project, with links to project details), and details view (which provides in-depth information about each project, including photos of many projects).

Case Studies of Concrete Inlay/Overlay Projects (CPAM 2021). The Concrete Paving Association of Minnesota (CPAM) provides 10 concrete overlay project case studies for download at http://www.concreteisbetter.com/elibrary/elib-casestudies/.

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 FHWA Pooled Fund Study TPF-5(165). The website (https://www.engineering.pitt.edu/Vandenbossche/BCOA-ME/) is a repository of all information relating to the BCOA-ME.

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