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

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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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Table of Contents
Acknowledgments ............................................................. vi
Types and Applications of Concrete Overlays ................................. 1
Sustainable Solutions ............................................................. 3
U.S. Concrete Overlays .............................................................. 3
Selected Case Histories ............................................................. 5
Case History #1 ................................................................. 6
Case History #2 ................................................................. 7
Case History #3 ................................................................. 8
Case History #4 ................................................................. 9
Case History #5 ................................................................. 10
Case History #6 ................................................................. 11
Case History #7 ................................................................. 12
Case History #8 ................................................................. 13
Case History #9 ................................................................. 14
Case History #10 ................................................................. 15
Case History #11 ................................................................. 16
Case History #12 ................................................................. 17
Additional Resources .............................................................. 18
References ........................................................................... 19

List of Figures & Tables
Figure 1. Forty-five states where concrete overlays have been constructed, with number of overlays in each state (1910–1969/[1970–2010]) ........................................ 1
Figure 2. Types of concrete overlays .............................................. 2
Figure 3. Concrete overlays are an over-arching solution for all pavements ................................................................. 2
Figure 4. Concrete overlays support sustainable principles .................. 3
Figure 5. Number of concrete overlay construction projects in the United States by decade ................................................................. 3
Figure 6. Percentage of each type of concrete overlay constructed from 1900–2010 ................................................................. 3
Figure 7. Percentage of concrete overlays by existing pavement type constructed from 1900–2010 ................................................................. 4
Figure 8. Percentage of bonded and unbonded concrete overlays by pavement type constructed from 1900–2010 ................................................................. 4
Figure 9. States where case study overlays were constructed (shaded blue) ................................................................. 5
Table 1. Listing of Case History Projects ........................................ 5
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 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.
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 2. Types of concrete overlays

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

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.

U.S. Concrete Overlays

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

**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.

![Figure 9. States where case study overlays were constructed (shaded blue)](image)

### Table 1. Listing of Case History Projects

<table>
<thead>
<tr>
<th>Case History #</th>
<th>State</th>
<th>Route</th>
<th>Year Constructed</th>
<th>Existing Pavement &amp;Overlay Type</th>
<th>Functional Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OK</td>
<td>US-69</td>
<td>2001</td>
<td>Asphalt</td>
<td>Bonded</td>
</tr>
<tr>
<td>2</td>
<td>MT</td>
<td>US-16</td>
<td>2001</td>
<td>Bonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>3</td>
<td>IL</td>
<td>Plank Rd</td>
<td>1974</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>4</td>
<td>CO</td>
<td>US-287</td>
<td>1998</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>5</td>
<td>UT</td>
<td>SR-89/114</td>
<td>2001</td>
<td>Bonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>6</td>
<td>IA</td>
<td>SH-13</td>
<td>2002</td>
<td>Bonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>7</td>
<td>IN</td>
<td>I-69</td>
<td>1986</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>8</td>
<td>OK</td>
<td>I-35</td>
<td>2004</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>9</td>
<td>IA</td>
<td>V-63</td>
<td>2002</td>
<td>Bonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>10</td>
<td>IL</td>
<td>I-88</td>
<td>1996</td>
<td>Bonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>11</td>
<td>MI</td>
<td>US-131</td>
<td>1998</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
<tr>
<td>12</td>
<td>NC</td>
<td>I-85</td>
<td>1998</td>
<td>Unbonded</td>
<td>Bonded</td>
</tr>
</tbody>
</table>
Case History #1

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Bonded concrete overlay on asphalt pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>4” &amp; 6”</td>
</tr>
<tr>
<td>Location</td>
<td>US-69 southbound lanes in Pittsburg County, OK</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>2001</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
<tr>
<td>Commentary</td>
<td>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”.</td>
</tr>
</tbody>
</table>

Performance

<table>
<thead>
<tr>
<th>Age</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>4” &amp; 6”</td>
</tr>
<tr>
<td>ESALs</td>
<td>10,100,000</td>
</tr>
</tbody>
</table>

Click here to view the Google Map

Typical Section

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Duit Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>Oklahoma DOT Division I</td>
</tr>
<tr>
<td>Owner</td>
<td>Oklahoma DOT</td>
</tr>
<tr>
<td>Project Length</td>
<td>≈ 1.5 miles</td>
</tr>
<tr>
<td>Overlay Joints</td>
<td></td>
</tr>
<tr>
<td>• Transverse Spacing</td>
<td>6’ c/c</td>
</tr>
<tr>
<td>• Longitudinal Spacing</td>
<td>6’ and 7’</td>
</tr>
<tr>
<td>• Dowel Bars</td>
<td>No</td>
</tr>
<tr>
<td>• Tie Bars</td>
<td>No</td>
</tr>
<tr>
<td>• Joint Sealing</td>
<td>No</td>
</tr>
<tr>
<td>Subdrains</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Existing Subbase Type</th>
<th>Granular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Details</td>
<td>Transverse joints sawed T/3 x 1/8” at 6’ c/c</td>
</tr>
<tr>
<td>Fibers (Used/Type/Dosage)</td>
<td>Yes/Macro/3lb. per yard³</td>
</tr>
<tr>
<td>Construction Details</td>
<td>Constructed one lane at a time with traffic adjacent to the paving operation</td>
</tr>
<tr>
<td>Pre-Overlay Repairs</td>
<td>None</td>
</tr>
<tr>
<td>Observed Distress(es)</td>
<td>2010 -38 slabs (&lt;1%) with visible cracks and joint spalling at centerline</td>
</tr>
<tr>
<td>Repairs to Date</td>
<td>Few necessary; some bituminous patches have been placed and minor cracking has been held tight with macro fibers</td>
</tr>
</tbody>
</table>
Case History #2

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Bonded concrete overlay on asphalt pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>4”</td>
</tr>
<tr>
<td>Location</td>
<td>SR-16 in Dawson County, MT</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>2001</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
<tr>
<td>Commentary</td>
<td>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”).</td>
</tr>
</tbody>
</table>

Typical Half Section

![Typical Half Section Diagram](Source: MTDOT Research Construction Report, Feb. 2002, Thin-Whitewater Overlap Composite)

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>Montana DOT</td>
</tr>
<tr>
<td>Owner</td>
<td>Montana DOT</td>
</tr>
<tr>
<td>Project Length</td>
<td>≈ 0.6 miles</td>
</tr>
<tr>
<td>Overlay Joints</td>
<td>4” c/c</td>
</tr>
<tr>
<td>Transverse Spacing</td>
<td>4”</td>
</tr>
<tr>
<td>Longitudinal Spacing</td>
<td>No</td>
</tr>
<tr>
<td>Dowel Bars</td>
<td>No</td>
</tr>
<tr>
<td>Tie Bars</td>
<td>No</td>
</tr>
<tr>
<td>Joint Sealing</td>
<td>No</td>
</tr>
<tr>
<td>Subdrains</td>
<td>No</td>
</tr>
<tr>
<td>Existing Subbase Type</td>
<td>Unknown</td>
</tr>
<tr>
<td>Design Details</td>
<td>Raised profile grade approximately 2½”</td>
</tr>
<tr>
<td>Fibers (Used/Type/Dosage)</td>
<td>Yes/Macro/3lb. per yard³</td>
</tr>
<tr>
<td>Construction Details</td>
<td>Constructed while maintaining local access</td>
</tr>
<tr>
<td>Pre-Overlay Repairs</td>
<td>Asphalt build up in areas where milling exposed base/subgrade</td>
</tr>
<tr>
<td>Observed Distress(es)</td>
<td>Approximately 30 (.5%) cracked panels as of 2008</td>
</tr>
<tr>
<td>Repairs to Date</td>
<td>Removal and full-depth repair of 15 (.2%) panels in 2005</td>
</tr>
</tbody>
</table>

Performance

| Age | 13 |
| Thickness | 4” |
| ESALs | 2,200,000 |

Click here to view the Google Map

**Case History #3**

**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.

---

**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**
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

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.

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
  Yes
- 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

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Bonded concrete overlay on composite pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>4”</td>
</tr>
<tr>
<td>Location</td>
<td>US-89 at SR-114 in Utah County, Provo, UT</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>2001</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
<tr>
<td>Commentary</td>
<td>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.</td>
</tr>
</tbody>
</table>

| Performance                  |                                               |
|------------------------------|                                               |
| Age                          | 13                                           |
| Thickness                    | 4”                                           |
| ESALs                        | 6,000,000                                    |

Typical Half Section

- CR-56 After 40 Years (2012)

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Workman Construction Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>Utah DOT Region 3</td>
</tr>
<tr>
<td>Owner</td>
<td>Utah DOT</td>
</tr>
<tr>
<td>Project Length</td>
<td>≈ .1 miles</td>
</tr>
<tr>
<td>Overlay Joints</td>
<td></td>
</tr>
<tr>
<td>Transverse Spacing</td>
<td>4’ c/c</td>
</tr>
<tr>
<td>Longitudinal Spacing</td>
<td>4’</td>
</tr>
<tr>
<td>Dowel Bars</td>
<td>No</td>
</tr>
<tr>
<td>Tie Bars</td>
<td>No</td>
</tr>
<tr>
<td>Joint Sealing</td>
<td>No</td>
</tr>
<tr>
<td>Subdrains</td>
<td>No</td>
</tr>
<tr>
<td>Existing Subbase Type</td>
<td>Unknown</td>
</tr>
<tr>
<td>Design Details</td>
<td>Variable depth milling was used to maintain the existing gutter profile</td>
</tr>
<tr>
<td>Fibers (Used/Type/Dosage)</td>
<td>Yes/Macro/3lbs. per yard³</td>
</tr>
<tr>
<td>Construction Details</td>
<td>Weekend construction</td>
</tr>
<tr>
<td>Pre-Overlay Repairs</td>
<td>None</td>
</tr>
<tr>
<td>Observed Distress(es)</td>
<td>Early cracking around utility structures, ultimately corner and longitudinal cracking caused by repetitive truck loading</td>
</tr>
<tr>
<td>Repairs to Date</td>
<td>A few individual panels around utility structures were replaced early in the life of the project</td>
</tr>
</tbody>
</table>
Case History #6

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Bonded concrete overlay on composite pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>4” nominal</td>
</tr>
<tr>
<td>Location</td>
<td>SH-13 from Manchester, IA north approximately 9.6 miles</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>2002</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
<tr>
<td>Commentary</td>
<td>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.</td>
</tr>
</tbody>
</table>

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 | Multiple options used |
| Transverse Spacing | Multiple options used |
| Longitudinal Spacing | No |
| Dowel Bars | Yes, stapled over widening units |
| Tie Bars | No |
| Joint Sealing | 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/yd³)/Fibrillated (3lbs/yd³)/Structural (3lbs/yd³) |
| 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 |

Performance

| Age | 12 |
| Thickness | 4” nominal |
| ESALs | 1,000,000 |

Click here to view the Google Map
Case History #7

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.

Performance

| Age | 28 |
| Thickness | 11" |
| ESALs | 47,500,000 |

Click here to view the Google Map

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

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Unbonded concrete overlay on composite pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>11½”</td>
</tr>
<tr>
<td>Location</td>
<td>I-35 7 miles north of Texas state line in Love County, OK</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>2004</td>
</tr>
</tbody>
</table>
| 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.

### Performance

<table>
<thead>
<tr>
<th>Age</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>11½”</td>
</tr>
<tr>
<td>ESALs</td>
<td>19,100,000</td>
</tr>
</tbody>
</table>

### Typical Section

I-35 Looking North (Feb. 2014)

I-35 Looking South (Oct. 2013)

### Typical Section Diagram

- **Concrete overlay (11.5”)**
- **Mill to This Line (approx. 2” remaining)**
- **Existing JPCP (approx. 9”)**
- **Existing Asphalt Overlay**

### 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 yd² of full-depth patching

### Observed Distress(es)

- None

### Repairs to Date

- None
Case History #9

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: Yes
- Joint Sealing: No
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

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Bonded concrete overlay on concrete pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>3”</td>
</tr>
<tr>
<td>Location</td>
<td>I-88 in Whiteside County, IL</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>1996</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
</tbody>
</table>

**Commentary**

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

---

**Typical Section**

- 4.0’ Existing Granular Base
- 12.0’ Existing 4” Stabilized Base
- 12.0’ 3” Bonded Concrete Overlay
- 4.0’ Existing 8” CRCP
- 10.0’ 3” Asphalt Shoulder (typical both sides)
- 12.0’ Longitudinal Joint (match underlying joint)

---

**Performance**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18</td>
</tr>
<tr>
<td>Thickness</td>
<td>3”</td>
</tr>
<tr>
<td>ESALs</td>
<td>16,800,000</td>
</tr>
</tbody>
</table>

---

**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

---

**Fibers**

- (Used/Type/Dosage): No

---

**Subdrains**

- No

---

**Existing Subbase Type**

- 4” Stabilized

---

**Design Details**

- Asphalt shoulders

---

**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

---

**Click here to view the Google Map**
### Case History #11

**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.

---

**Typical Section**

- **Existing 9” JRCP**
- **7” Dowel Jointed Concrete Pavement**
- **12.0’**
- **4.0’**
- **12.0’**
- **10.0’**
- **7” Tied Concrete Shoulder (typical both sides)**
- **Existing Base and Subbase (4” clean granular & 14” sand)**
- **Existing Asphalt Shoulder (typical both sides)**
- **Asphalt Interlayer**

---

**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**
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

---

**Performance**

<table>
<thead>
<tr>
<th>Age</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>±7”</td>
</tr>
<tr>
<td>ESALs</td>
<td>8,000,000</td>
</tr>
</tbody>
</table>

---

Source: Google Earth 2014
## Case History #12

<table>
<thead>
<tr>
<th>Overlay Type</th>
<th>Unbonded concrete overlay on concrete pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay Thickness</td>
<td>10”</td>
</tr>
<tr>
<td>Location</td>
<td>I-85 in Granville County, NC</td>
</tr>
<tr>
<td>Year Constructed</td>
<td>Three projects from 1997 to 2001</td>
</tr>
<tr>
<td>Traffic</td>
<td>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)</td>
</tr>
<tr>
<td>Commentary</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Typical Section

- **Northbound I-85 (July 2013)**

<table>
<thead>
<tr>
<th>Contractor</th>
<th>APAC Tennessee/Southern Roadbuilders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>North Carolina DOT</td>
</tr>
<tr>
<td>Owner</td>
<td>North Carolina DOT</td>
</tr>
<tr>
<td>Project Length</td>
<td>≈ 17.3 miles</td>
</tr>
<tr>
<td>Overlay Joints</td>
<td></td>
</tr>
<tr>
<td>Transverse Spacing</td>
<td>Average 20’</td>
</tr>
<tr>
<td>Longitudinal Spacing</td>
<td>12’</td>
</tr>
<tr>
<td>Dowel Bars</td>
<td>Yes</td>
</tr>
<tr>
<td>Tie Bars</td>
<td>Yes, at centerline joint</td>
</tr>
<tr>
<td>Joint Sealing</td>
<td>Yes</td>
</tr>
<tr>
<td>Subdrains</td>
<td>Yes</td>
</tr>
<tr>
<td>Existing Subbase Type</td>
<td>Unknown</td>
</tr>
<tr>
<td>Design Details</td>
<td>Design thickness is a nominal 1” thinner than typical NCDOT reconstruction alternative</td>
</tr>
<tr>
<td>Fibers (Used/Type/Dosage)</td>
<td>No</td>
</tr>
<tr>
<td>Construction Details</td>
<td>Two projects constructed adjacent to traffic and the third was paved 24’ wide</td>
</tr>
<tr>
<td>Pre-Overlay Repairs</td>
<td>Minimal</td>
</tr>
<tr>
<td>Observed Distress(es)</td>
<td>Mid-panel cracking (1.5%), 98% of cracked slabs are in the first project constructed</td>
</tr>
<tr>
<td>Repairs to Date</td>
<td>Full-depth patching (.2%) and crack sealing</td>
</tr>
</tbody>
</table>
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 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 white-topping. The website is a repository of all information relating to the BCOA-ME.

**References**


Cable, J. 2012. *Concrete Overlay Field Application Program Iowa Task Report: US 18 Concrete Overlay Construction under Traffic*. National Concrete Pavement Technology Center, Iowa State University, Ames, IA.

Concrete Paving Association of Minnesota (CPAM) [no year]. *Concrete Inlay/Overlay Projects* (case studies). (www.concreteisbetter.com/elibrary/elib-casestudies/; accessed Nov. 7, 2014).


