Concrete Overlays Over Existing Asphalt Parking Lots

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National Ready Mixed Concrete Association

- National Trade Association – Established in 1930
- HQ in Alexandria, VA
- 1,400+ Member Companies
- NRMCA Represents ~75% of North American Ready Mixed Production
- Mission - Serve Industry and Partners Through:
  - Compliance and Operations
  - Engineering
  - Government Affairs
  - *Local Paving: Pave Ahead™ Initiative (PaveAhead.com)*
  - *Structures and Sustainability: Build With Strength™ Initiative*

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NRMCA Local Paving Division:
Technical and Promotion Personnel - Regional Assignments

www.PaveAhead.com

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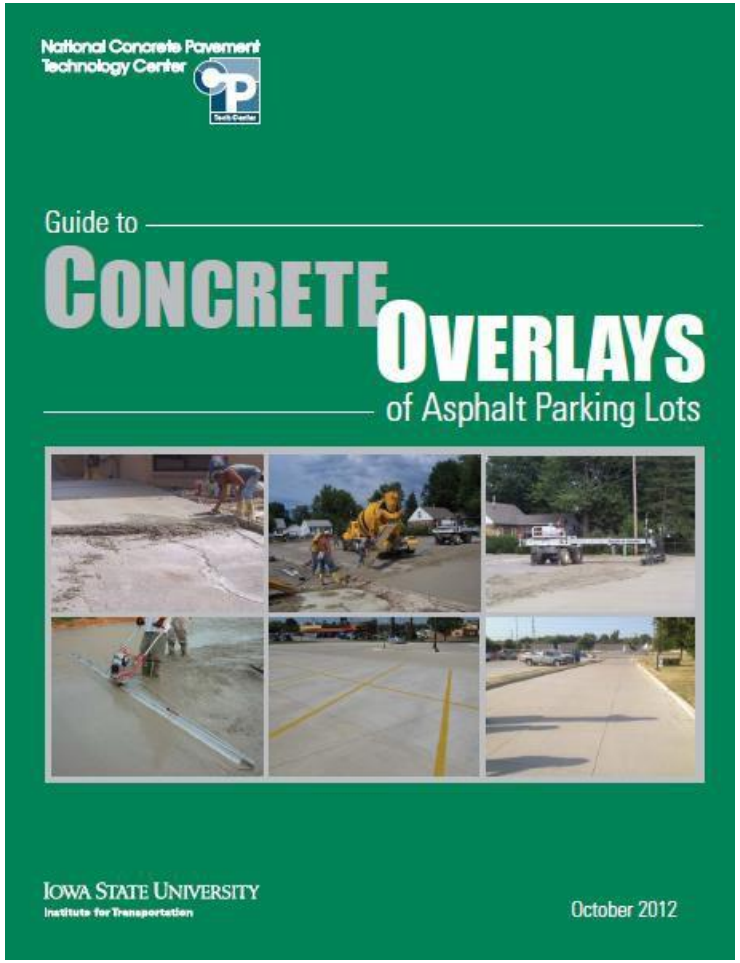
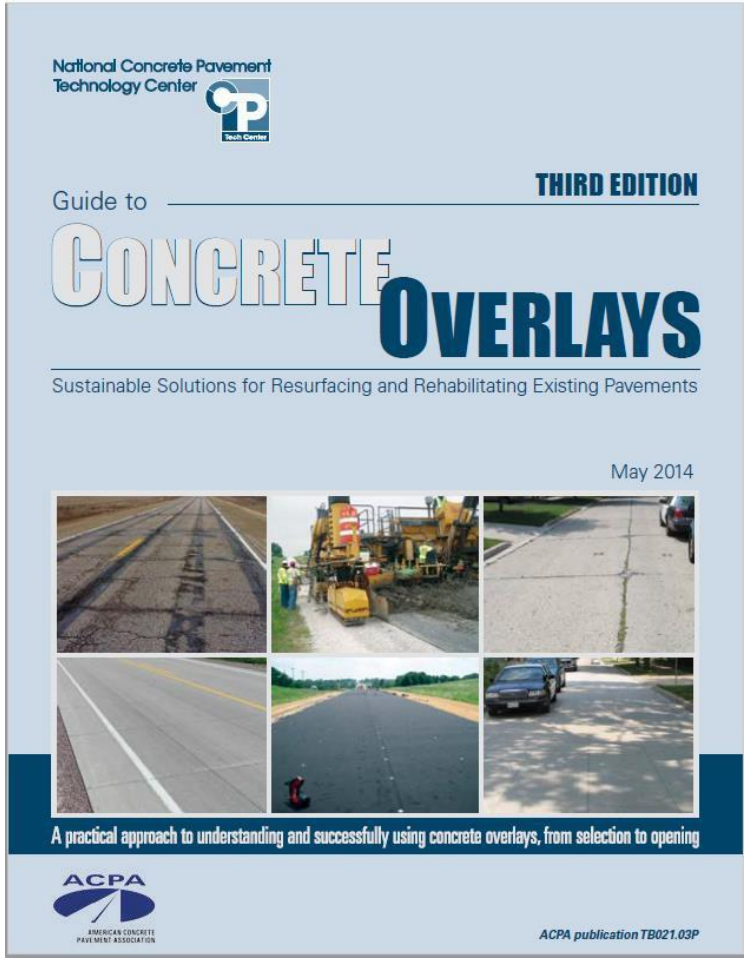
Learning Objectives

- Learn how to evaluate and assess an existing asphalt parking lot for a concrete overlay.
- Understand how to determine the thickness of concrete required to be placed over the asphalt.
- Learn the various construction techniques and how to determine the proper joint spacing.
- Discover which details and specification criteria are especially important for these projects.

Concrete Overlay Guides





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Concrete Overlays in Colorado

- First projects in recent past were constructed in late 1980's
- CDOT has built over 1.5M SY of 6-inch concrete overlays
- CDOT has built over 10M SY of concrete overlays of all thicknesses

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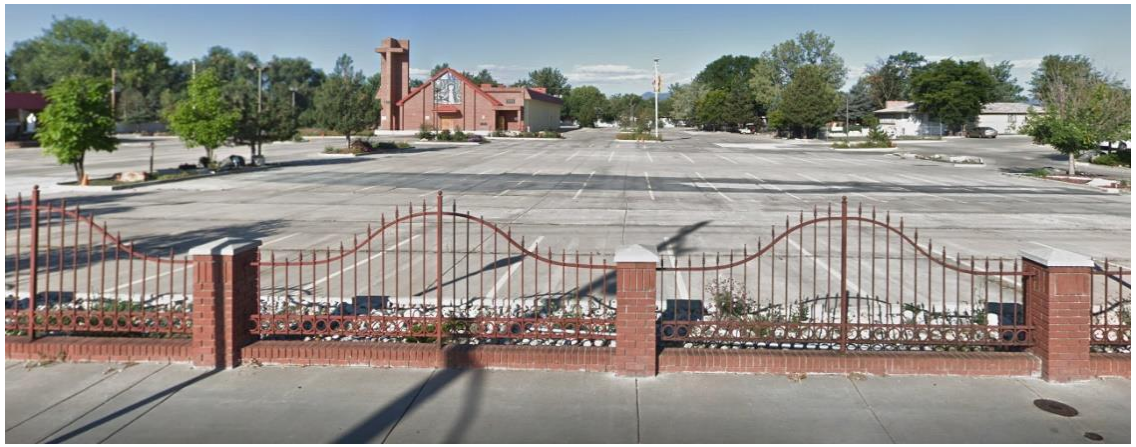
Early Parking Lot Overlays

- Result of owners and contractors looking to find solutions to improve deteriorated asphalt parking lots
- Innovative approach with limited initial design



Queen of Vietnamese Martyrs Church
Wheat Ridge, CO - Circa 1991

Doctor's Office in Monte Vista, CO
Circa 1988 (Photo in 2018)

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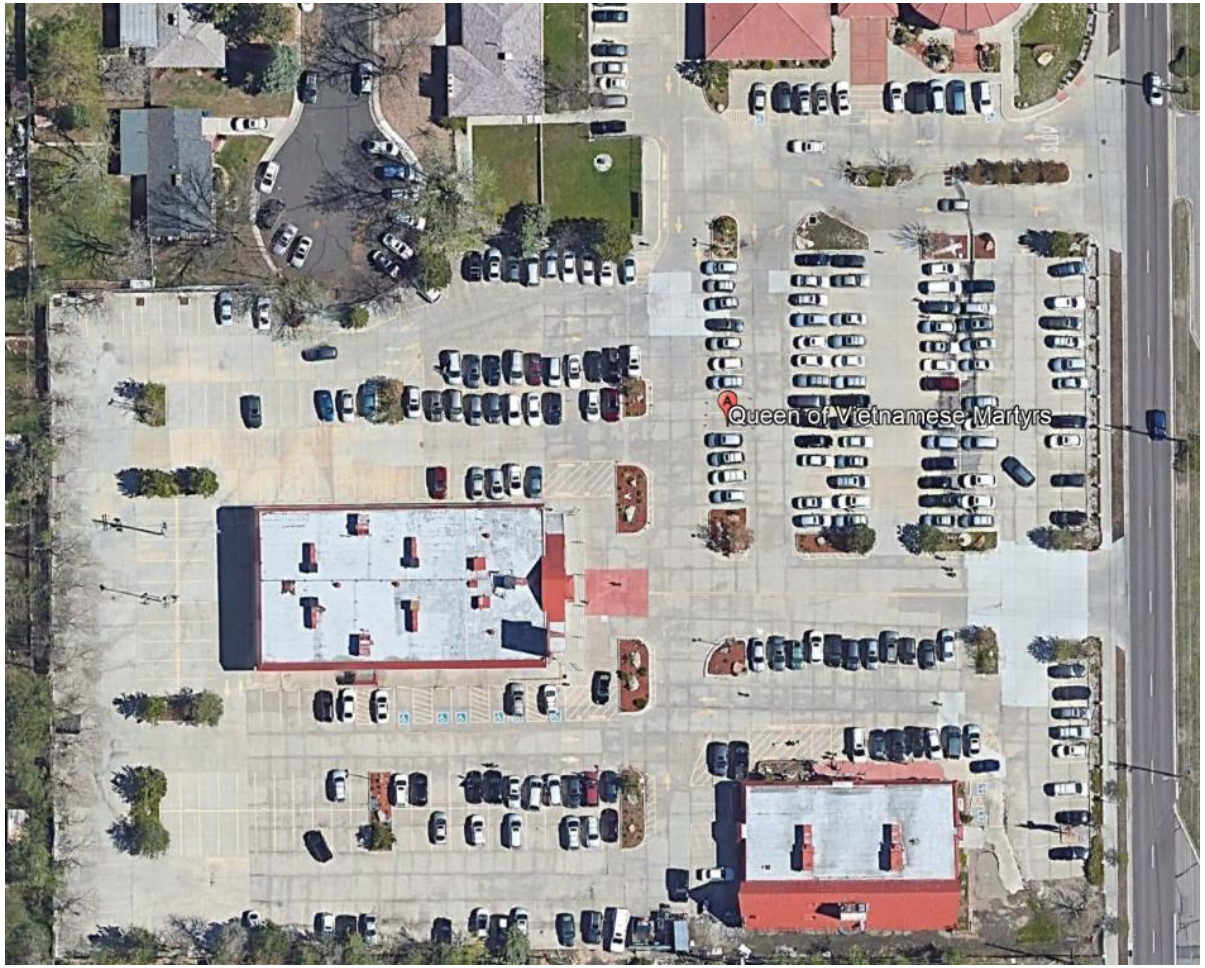
Queen of Vietnamese Church at 25 years



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I-70 Mack, Colorado Built in 2013

April 18, 2018 – 5 years old – no cracks!

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Why Specify a Concrete Overlay

- May be cheaper first cost compared to remove and replace
- Better use of materials already purchased by agency or owner
- Minimize future maintenance costs
- Attractive, bright welcome mat for business

Concrete is Brighter at Night

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Parking lot Selection – Assessing Existing Pavement Condition

- Always necessary to confirm suitability
- Asphalt pavements with “low to moderate severity surface distress” are suitable for PCCP bonded overlays
- Asphalt pavements with “high severity surface distress” are suitable for new PCCP (IE unbonded overlays), not bonded overlays

Pavement Condition Assessment

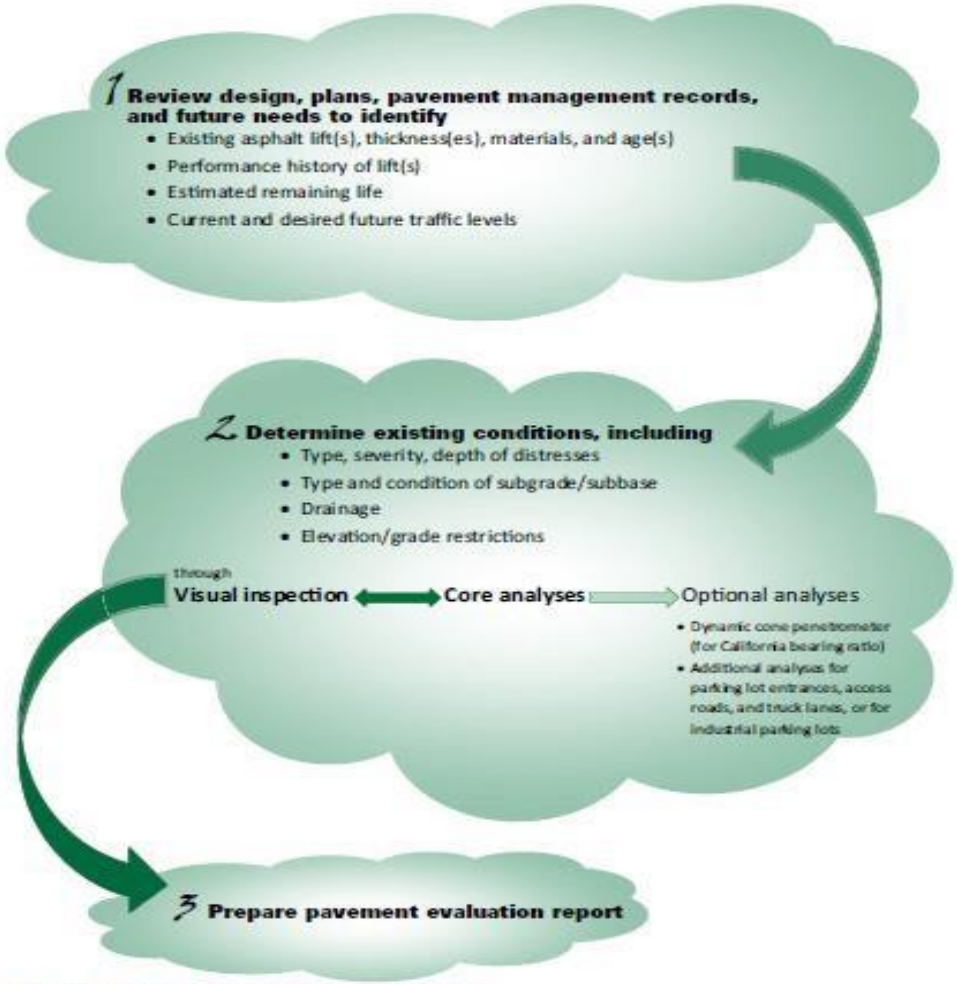

Figure 5. Flowchart of asphalt parking lot pavement condition assessment

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Step 1 – Review Available Data

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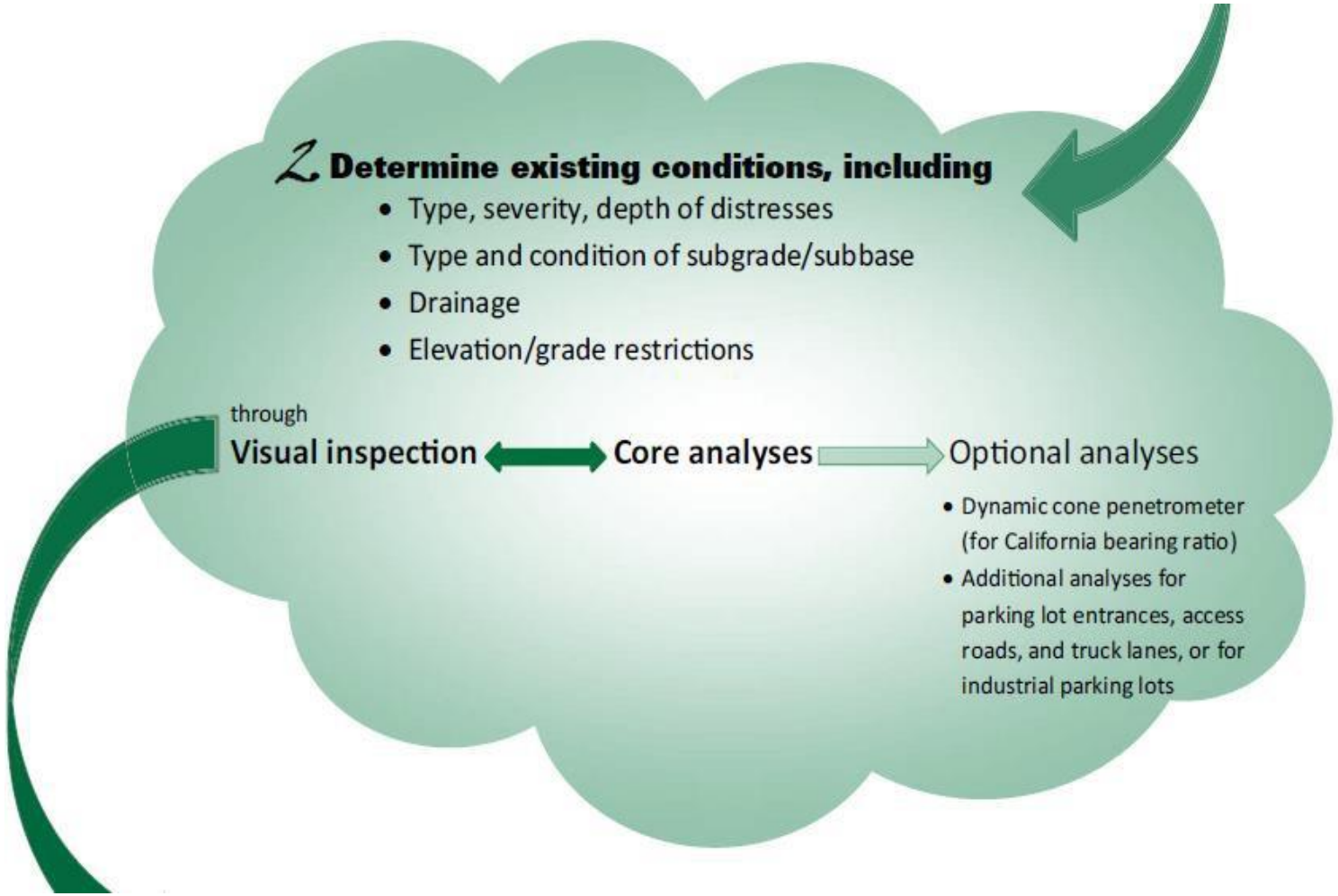
Potential Data Sources for History

- Design reports
- Construction plans/specifications
- Laboratory test reports
- Past pavement condition surveys
- Maintenance/repair histories
- Traffic Measurements/forecasts

Step 2 - Determine Existing Conditions



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Goal of Step 2

- Determine the type and severity of any pavement distress and condition of subgrade support
- Identify any drainage problems and potential restrictions regarding elevation

Goal of Step 2 – Core Analysis

- Generally, 2–4-inch cores are taken from asphalt/subgrade
- Thickness and condition of HMA/subgrade can be noted
- IMPORTANT – note any fabric between asphalt layers
- Take enough cores to be confident of the minimum thickness of the asphalt

7. Typical core of asphalt parking lot with granular subbase

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Don’t skip the Coring

Figure 8. Failure of concrete overlay sections in locations where the existing asphalt pavement surface was entirely removed through milling because of lack of core information

Identifying Pavement Distresses and Severity Levels

- Alligator cracking
- Potholes/popouts
- Thermal cracking
- Access or truck lane rutting
- Block cracking
- Raveling
- Random cracking
- Access or truck lane shoving

Levels of Severity

- Two classifications per Guide
- Low-to-medium (surface) severity
- High-severity (subsurface or loading) distress
- Low-to-moderate severity parking areas are candidates for PCCP bonded overlays

Alligator Cracking

Figure 10a. Low- to medium-severity alligator cracking

Figure 10b. High-severity alligator cracking

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Block Cracking

Figure 11a. Low- to medium-severity block cracking

Figure 11b. High-severity block cracking

Potholes/ Popouts

Figure 12a. Low- to medium-severity pothole

Figure 12b. High-severity pothole

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Raveling

Figure 13a. Low- to medium-severity raveling

Figure 13b. High-severity raveling

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Thermal Cracking

Figure 14a. Low- to medium-severity thermal cracking

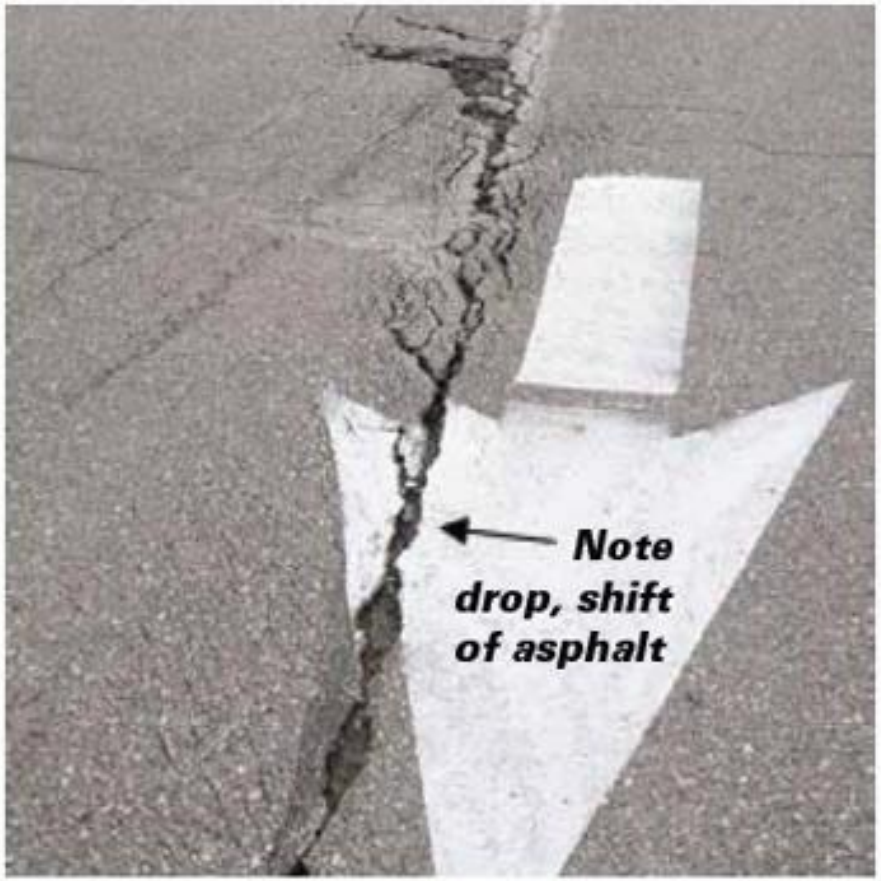

Figure 14b. High-severity thermal cracking

Random Cracking

Figure 15a. Low- to medium-severity random cracking

Figure 15c. High-severity random cracking

Step 3 – Prepare Report

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To Recap ….A Good Overlay Parking lot Candidate

- Pavement exhibits low-to-medium (surface) severity
- At least two inches of existing asphalt, preferably 3 inches
- Minimal vertical constraints along edges of project relative to area of overlay
- No paving fabric between pavement layers

Bonded Concrete Overlay Design

- Thickness design
- Jointing design
- Transitions

Parking Lot Design Parameters

- For most light duty parking lots, thickness of PCCP overlay is 3-6 inches
- Design is based on either full or partial bond with existing asphalt pavement, forming a composite pavement
- Composite K-values in Guide are based on ACI 330R-08, table 3.2
- Guide thickness charts are based on American Concrete Pavement Association's modified BCOA design program

ACPA BCOA Design Inputs

- Equivalent single axle loads (ESALs)
- % of allowable cracks
- Reliability
- Temperature gradient (region specific)
- Existing asphalt thickness and modulus
- K-value of subgrade/ subbase
- Concrete strength, modulus, and coefficient of thermal expansion
- Joint spacing and pre-overlay surface prep

Zone Concept

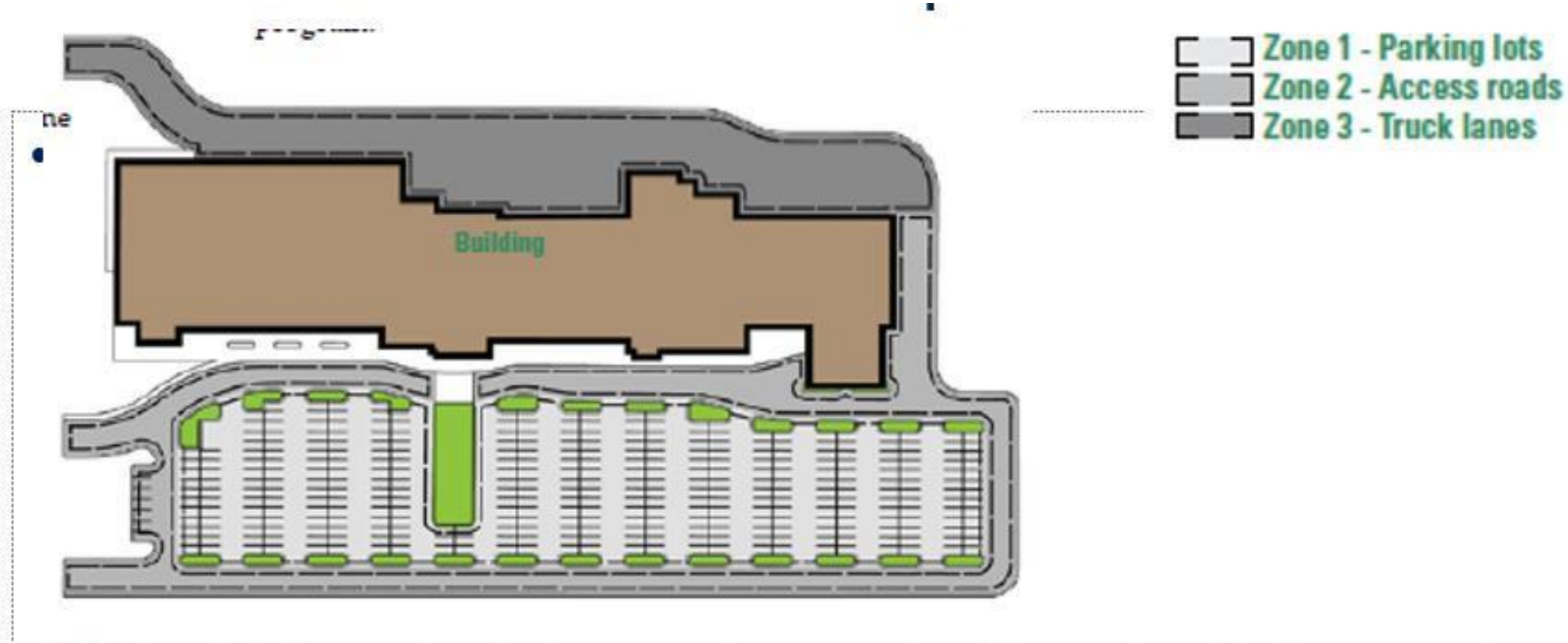

Figure 19. The "zone design" concept for parking lots assumes that access roads, truck lanes, and general parking areas experience different traffic loadings and, thus, the concrete overlays for those zones should be designed separately

Guide Design Tables

- Each table includes thicknesses for Zones 1, 2, & 3
- Three tables, one for Des Moines, one for Sacramento, & one for Gainesville
- Existing asphalt varies from 2-6 inches
- Joint spacing varies from 4-6 feet
- Fiber and no fiber
- Concrete compressive strength of 4,000 and 4,500 PSI

Design Assumptions

- 20 - year design
- 50% directional distribution
- 75% design lane distribution
- 2 % growth rate of traffic
- 30% cracked slabs at end of design life
- 80% reliability
- 300,000 psi asphalt modulus of Elasticity

Design Assumptions

- 100 pci K-value for subgrade under asphalt
- 25% residual strength ratio (with fibers)
- 3,600,000 psi concrete modulus of elasticity
- Pre-overlay prep – asphalt is cleaned only (not milled)
- Coefficient of thermal expansion based on limestone
- Thickness values are rounded up to nearest 0.5 inch

Example – Des Moines Chart

Table 6. Typical Bonded Concrete Overlay Thickness over Asphalt where Mean Annual Daily Temperatures are 45–50°F (e.g., Des Moines, IA)

Zone 1: Parking Lot Area (≤ 200 Light Vehicles/Day and ≤ 1 Truck (0.32 ESAL/truck)/Day

Existing Asphalt Thickness (in.)	Concrete Compressive Strength (psi) / Flexural Strength (psi) (third point)	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing
		Thickness (in.) (no fiber)			Thickness (in.) (with fiber)		
2.0	4,000 / 630	4.0	4.5	5.0	3.5	3.5	4.0
2.0	4,500 / 670	4.0	4.5	4.5	3.0	3.5	4.0
3.0	4,000 / 630	3.5	4.0	4.5	3.0	3.0	3.5
3.0	4,500 / 670	3.5	4.0	4.5	3.0	3.0	3.5
4.0	4,000 / 630	3.0	3.5	4.0	3.0	3.0	3.0
4.0	4,500 / 670	3.0	3.5	4.0	3.0	3.0	3.0
6.0	4,000 / 630	3.0	3.0	3.0	3.0	3.0	3.0
6.0	4,500 / 670	3.0	3.0	3.0	3.0	3.0	3.0

Zone 2: Access Road (≤ 1,000 Light Vehicles/Day and ≤ 10 Trucks (0.35 ESAL/truck)/Day

Existing Asphalt Thickness (in.)	Concrete Compressive Strength (psi) / Flexural Strength (psi) (third point)	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing
		Thickness (in.) (no fiber)			Thickness (in.) (with fiber)		
2.0	4,000 / 630	5.0	5.5	6.0	3.5	4.0	4.5
2.0	4,500 / 670	4.5	5.0	5.5	3.5	4.0	4.5
3.0	4,000 / 630	4.5	5.0	5.5	3.5	4.0	4.0
3.0	4,500 / 670	4.0	4.5	5.0	3.0	3.5	4.0
4.0	4,000 / 630	3.5	4.5	5.0	3.0	3.0	3.5
4.0	4,500 / 670	3.5	4.0	4.5	3.0	3.0	3.5
6.0	4,000 / 630	3.0*	3.0*	3.0*	3.0	3.0	3.0
6.0	4,500 / 670	3.0*	3.0*	3.0*	3.0	3.0	3.0

Zone 3: Truck Lane (≤ 1,000 Light Vehicles/Day and ≤ 25 Trucks (0.600 ESAL/truck)/Day

Existing Asphalt Thickness (in.)	Concrete Compressive Strength (psi) / Flexural Strength (psi) (third point)	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing
		Thickness (in.) (no fiber)			Thickness (in.) (with fiber)		
2.0	4,000 / 630	5.5	6.0	6.0	4.0	4.5	5.0
2.0	4,500 / 670	5.0	5.5	6.0	4.0	4.0	4.5
3.0	4,000 / 630	5.0	6.0	6.0	3.5	4.0	4.5
3.0	4,500 / 670	4.5	5.0	6.0	3.5	4.0	4.0
4.0	4,000 / 630	4.0	5.0	6.0	3.0	3.5	4.0
4.0	4,500 / 670	4.0	4.5	5.0	3.0	3.0	3.5
6.0	4,000 / 630	3.0*	3.0*	4.0	3.0	3.0	3.0
6.0	4,500 / 670	3.0*	3.0*	3.0*	3.0	3.0	3.0

Notes: k-value = 100 pci (or 100 psi/in.) (for the area below the existing asphalt and representing the composite value of the subgrade/subbase)
* = low-severity asphalt distress

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Example – Des Moines, Zone 2 Assess Road

Zone 2: Access Road (≤ 1,000 Light Vehicles/Day and ≤ 10 Trucks (0.35 ESAL/truck)/Day							
Existing Asphalt Thickness (in.)	Concrete Compressive Strength (psi) / Flexural Strength (psi) (third point)	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing	4-ft Joint Spacing	5-ft Joint Spacing	6-ft Joint Spacing
		Thickness (in.) (no fiber)			Thickness (in.) (with fiber)		
2.0	4,000 / 630	5.0	5.5	6.0	3.5	4.0	4.5
2.0	4,500 / 670	4.5	5.0	5.5	3.5	4.0	4.5
3.0	4,000 / 630	4.5	5.0	5.5	3.5	4.0	4.0
3.0	4,500 / 670	4.0	4.5	5.0	3.0	3.5	4.0
4.0	4,000 / 630	3.5	4.5	5.0	3.0	3.0	3.5
4.0	4,500 / 670	3.5	4.0	4.5	3.0	3.0	3.5
6.0	4,000 / 630	3.0*	3.0*	3.0*	3.0	3.0	3.0
6.0	4,500 / 670	3.0*	3.0*	3.0*	3.0	3.0	3.0

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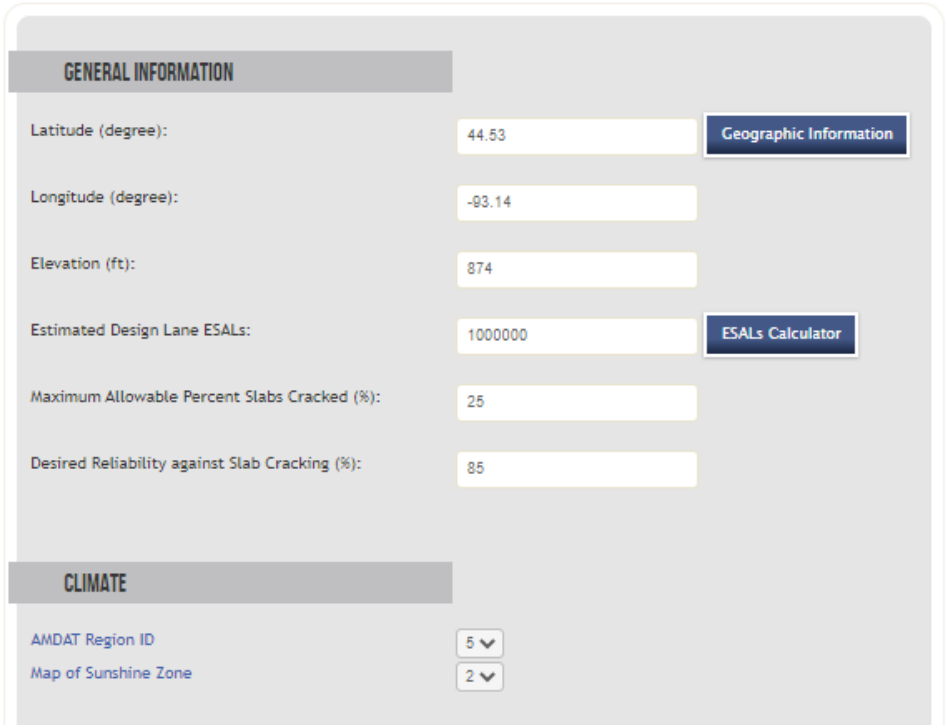
Concrete Overlay Design for Roadways

(Last updated: 4/21/2015)



https://www.engineering.pitt.edu/Vandenbossche/BCOA-ME/

Or google “BCOA Pitt”

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Requirements for Severe Environments

Exposure Condition	Max. w/cm	Min. compressive strength (f'_c) MPa (psi)
Concrete intended to have low permeability when exposed to water	0.50	28 (4000)
Concrete exposed to freezing and thawing in a moist condition or to deicing chemicals	0.45	31 (4500)
For corrosion protection of reinforcement in concrete exposed to chlorides	0.40	35 (5000)

Adapted from ACI 318-14 *Building Code Requirements for Structural Concrete*

Synthetic fibers

- Reduce plastic shrinkage cracks
- Reduce plastic settlement cracks
- Increase toughness and impact resistance

Synthetic Fibers – ASTM C1116

- Micro Fibers
  ½ - ¾ inch in length
  Help prevent plastic shrinkage cracks
  Dosage normally .5 – 1.5 lbs./ CY
  Provide surface toughness

- Macro Fibers (structural)
  Provide same benefits as micro-fibers, plus
  Can replace temperature/ shrinkage reinforcement
  Reduce shrinkage cracks (long term)
  1 ½ - 2 inches in length
  Dosage normally 3-5 lbs./ CY
  Recognized in concrete overlay designs

Construction

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Illinois Case Study – Glen West Middle School – Lombard, IL

Why concrete?

New Full Depth Asphalt Bid
12” of Stone with 2” asphalt base course and 1.5” of asphalt surface course
$292,870.00

Concrete Overlay
4” concrete overlay with a 5’ x 5’ saw cut pattern and 4 lbs. of Macro Fibers
Including milling of existing asphalt and some full depth 6” and 7” thick concrete pavement
$219,828.00
Cost Savings for the concrete overlay: $73,042.00

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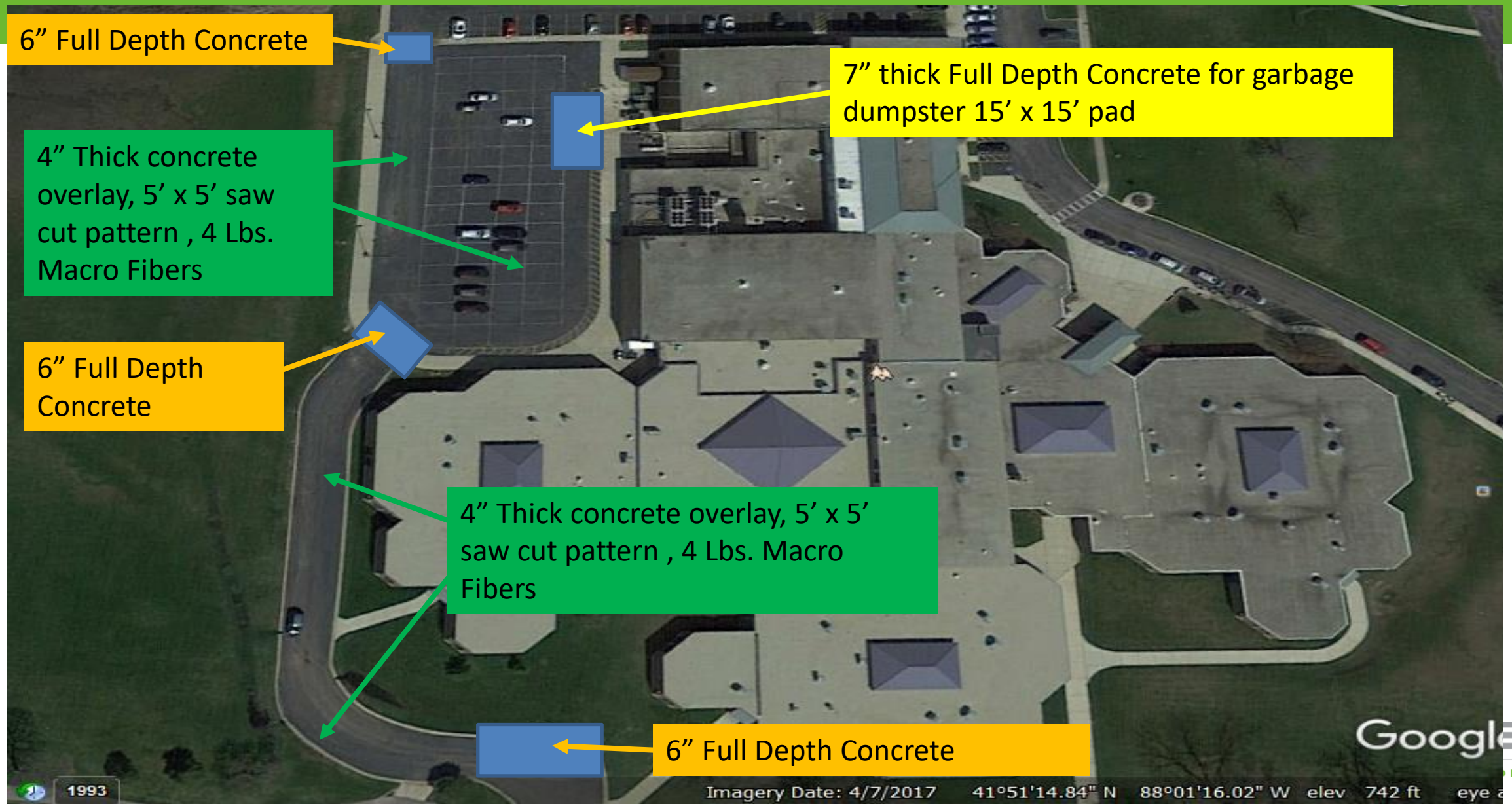
concrete overlay and full depth concrete design.



Roadway Preparation

The contractor milled 1.5” to 2.0” of asphalt on the road.

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Parking lot Preparation

The asphalt pavement was cleaned with a power washer before the concrete overlay was placed on top

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Transitions

A small amount of full depth removal was required to transition from one pavement to another

Transitions

Some milling was done to the asphalt pavement along side the existing sidewalk.

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Concrete Placement

The concrete overlay mix design is delivered in the concrete truck and placed directly on top of the existing asphalt. A .45 w/c concrete mix that achieves 4500 psi at 28 days should be used. Also 4 to 5 lbs. per cubic yard of a macro fibers is added to the concrete to minimize or eliminate cracking

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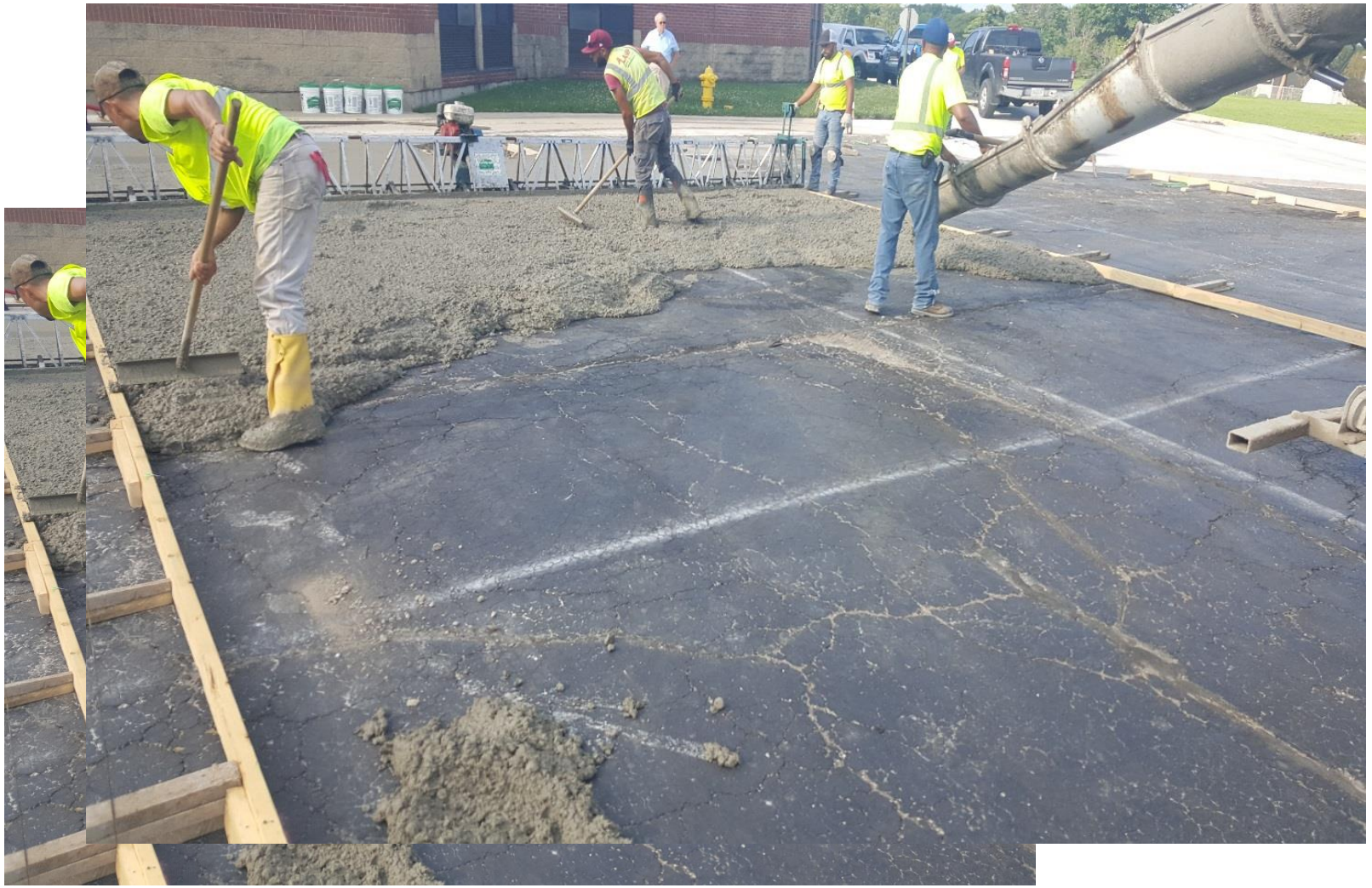
Concrete Placement



Concrete is placed directly onto the existing asphalt surface

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Concrete Placement

The concrete is leveled in the transverse direction to remove high and low spots

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Concrete finish

Broom finish is preferred surface texture

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Concrete finish

Expect to see some fibers on the surface of the freshly broomed concrete. These fibers will wear off of the surface over time.

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Tie to existing sidewalk

Tiebars were used to tie the new concrete overlay to the existing sidewalk

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Utilities

Existing sewers are raised with rings to be flush with the top of the concrete overlay. The sewers are the framed out and concrete is placed around the sewer after the surrounding concrete has hardened

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Curing is critical

The concrete overlay should be cured immediately after the broom finish is applied. An IDOT approved white pigmented curing compound is recommended

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Saw Cutting

An early entry saw should be used to saw cut the joint pattern. The saw cuts should be constructed the same day the concrete has been placed to avoid cracking in the concrete overlay

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Concrete Testing

An independent lab of record should be hired by the owner of the project to test the concrete for Air, Slump, Unit Weight, and Temperature. Cylinders should also be cast to verify that the concrete delivered meets the strength that was specified for the project. All testing must comply with ASTM standards.

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Before

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After Concrete Overlay

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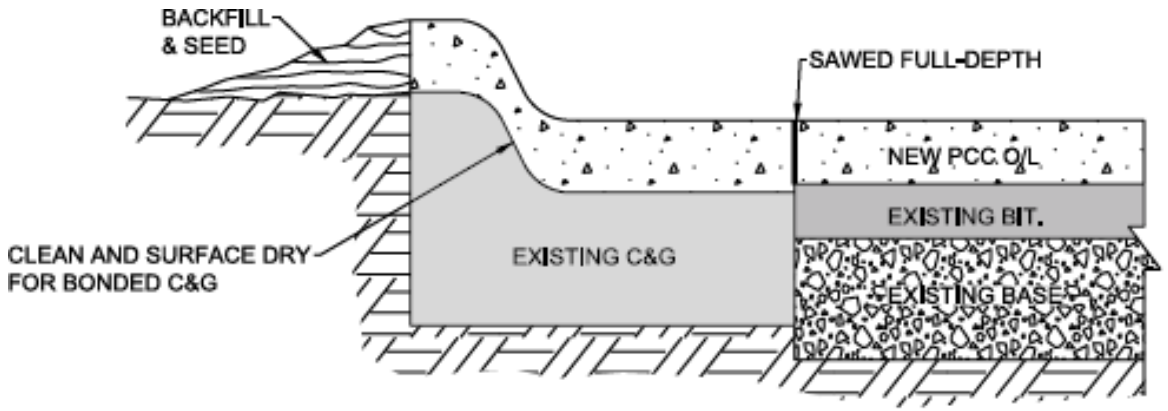
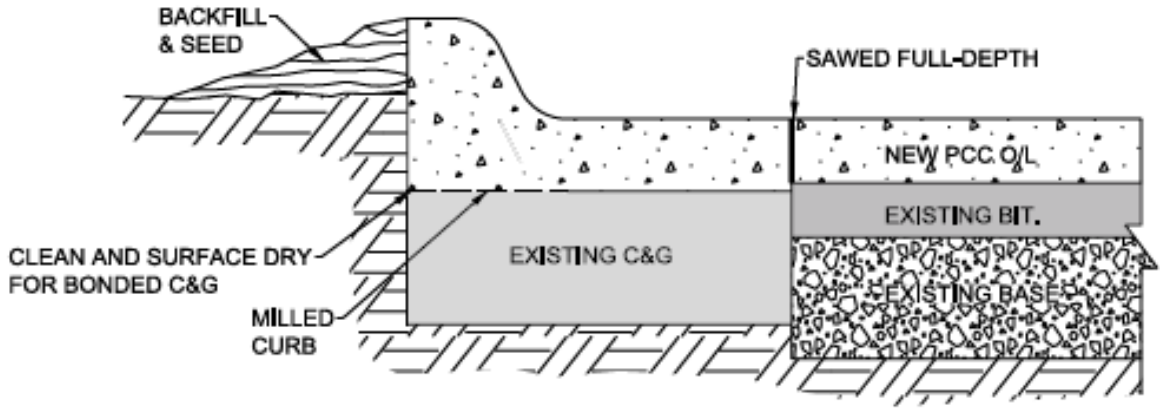
Specifications and Details



RAISING CURB & GUTTER DETAIL



MILLED CURB WITH OVERLAY DETAIL

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Curb Overlay – Paving Machine

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Thorncreek – Curb Overlay

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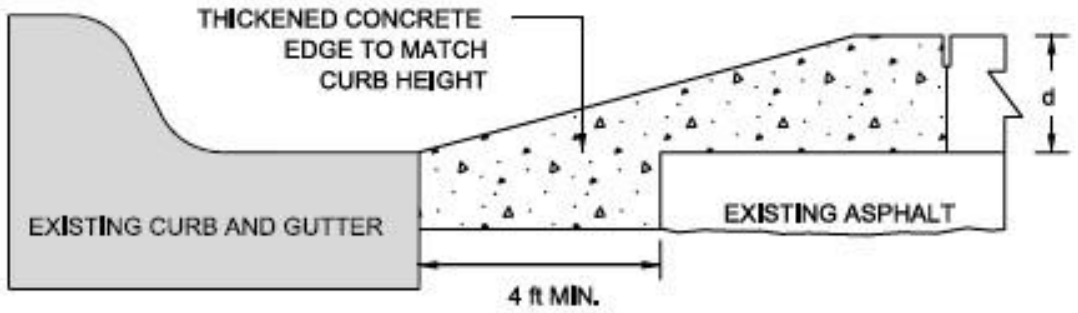
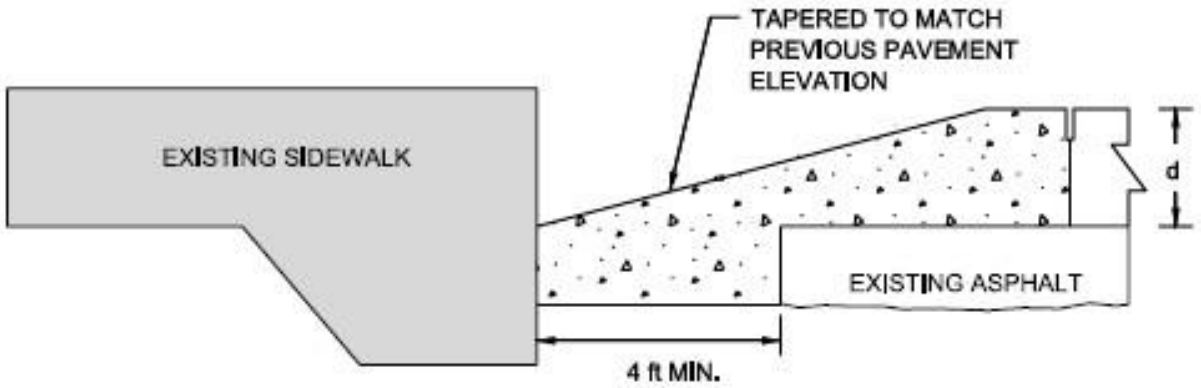
Detail – Transition Sections



TRANSITION SECTION
(AT EXISTING CURB AND GUTTER)



TRANSITION SECTION
(AT EXISTING SIDEWALK)

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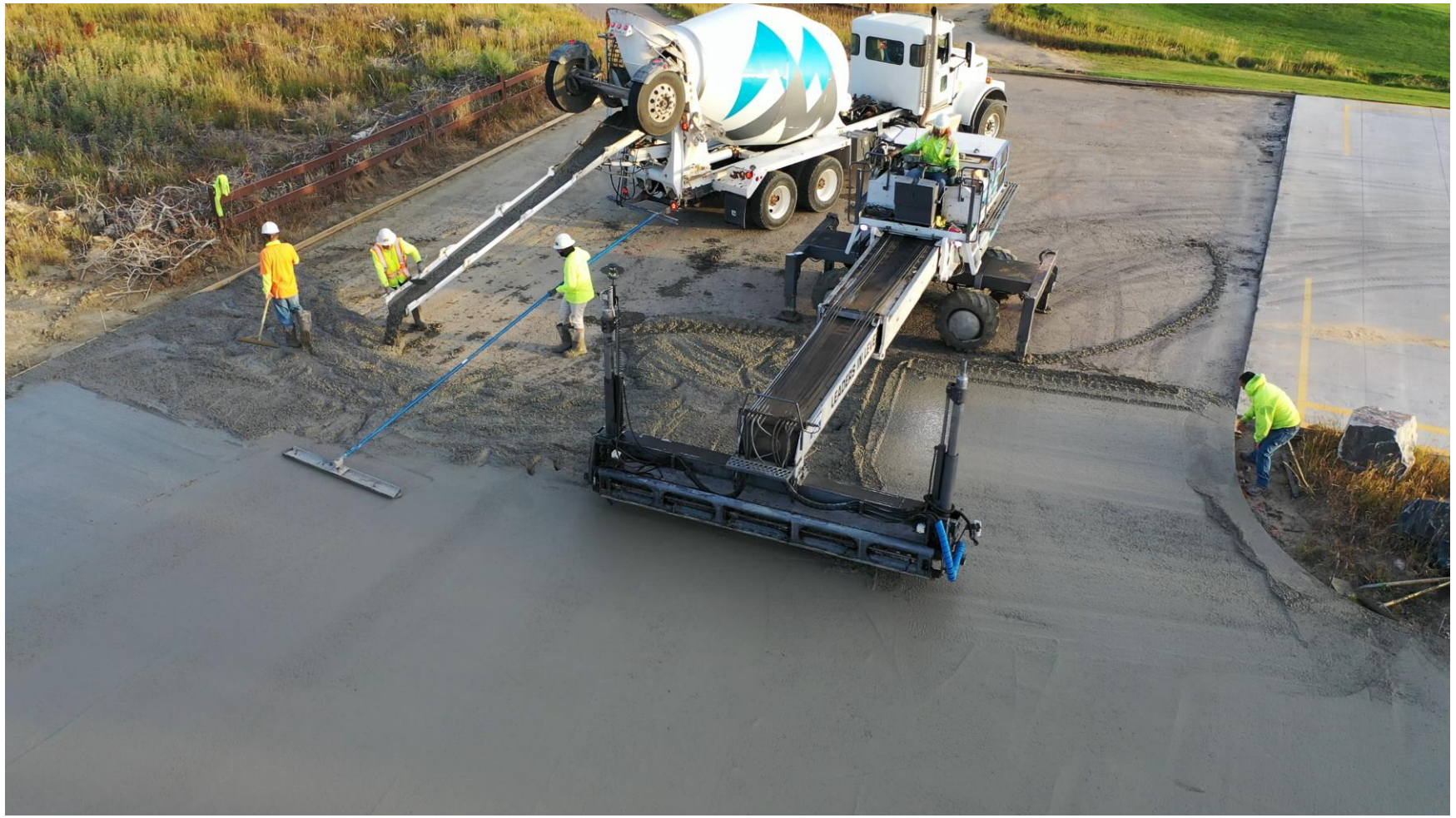
Meadows Golf Course -



3.5 inches to 4.5 inches thick concrete on

2.5 inches to 4.0 inches thick asphalt

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Meadows Golf Course -

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Thorncreek Golf Course - Thornton

Before

3-inch and 4-inch concrete overlay over 2-inch asphalt, 5 foot joint spacing

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Thorncreek Golf Course – Finished Project

DEN Pikes Peak Shuttle Lot - Denver

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Pikes Peak – Finished Phase 1

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DAC Lessons Learned

- You must determine the minimum thickness of the asphalt
- If you find paving fabric, design as an **unbonded** concrete overlay
- Consider the thickness shown in the charts as minimum. Contractor must be able to avoid sections thinner than these minimums
- Make sure that the existing asphalt is cleaned, and not too hot (>120 F)
- Heavy coat of curing compound is absolutely critical
- Ensure that the pavement is not loaded prematurely (IE before reaching 2,500 psi)

NRMCA Resources

- Design Assistance Program
- Jointing Plan Assistance
- www.paveahead.com - case studies
- www.pavementdesigner.org

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We're here to help…Questions?…Thank You

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- https://cptechcenter.org/
- https://www.cement.org/
- https://cshub.mit.edu/
- https://www.ascconline.org/
- http://www.acpa.org/

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Questions???

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