Chapter/States Associations of ACPA

Streets & Local Roads

American Concrete Pavement Association
SLR Pavement Markets

- New/Reconstruction of Concrete Pavements
- Concrete Overlays
  - Unbonded
  - Whitetopping
  - Ultra-Thin Whitetopping (UTW)
- Concrete Inlays
  - Intersections
  - Roundabouts
  - Bus Pads
  - Alleys
- Concrete Pavement Restoration
Different Pavement Types

Concrete Section
- Subgrade
- Subbase

Asphalt Section
- Subgrade
- Subbase
- Base
- Asphalt Layer
Concrete’s Rigidness spreads the load over a large area and keeps pressures on the subgrade low.
Streets and Local Roads Thickness Design Procedure

- Longitudinal joint
- Transverse joint
- Subgrade
- Subbase or base
- Surface Texture (Surface smoothness or rideability)
- Concrete materials
- Dowel bars
- Thickness Design
- Tiebars
Concrete Pavement Types

- Jointed Plain
  - Undoweled
  - Doweled

- Jointed Reinforced

- Continuously Reinforced
Jointed Plain

Plan

8 – 15 ft

Profile

or
Jointed Plain
Concrete Pavement Design Requires Selecting Appropriate Features

- Subgrade modification
- Drainage system
- Subbase
- Joint Spacing
  - 15 ft
  - 18 ft
- Dowels
- Thickness
  - 6 in
  - 8 in
  - 10 in
- Reinforcement
- Joint Sealant
  - None
  - Hot pour
  - Silicone
  - Preformed
- Surface Texture
  - Transverse tine
  - Burlap drag
- Shoulder
  - Asphalt
  - Concrete
Now Using Mechanistic-Empirical Design (MEPDG) to Optimize
Thickness Design Procedures

- **Empirical Design Procedures**
  - Based on observed performance
    - AASHO Road Test

- **Mechanistic Design Procedures**
  - Based on mathematically calculated pavement responses
    - PCA Design Procedure (PCAPAV)
    - StreetPave (ACPA Design Method)

Ottawa, Illinois (approximately 80 miles southwest of Chicago) between 1956 and 1960
New Design Tools for SLR

- MEPDG – Mechanistic-Emperical Design Guide
- StreetPave Software
  - Concrete Thickness
  - Asphalt Institute Design Thickness
  - Life Cycle Cost Analysis
- Information Sheet IS184
- Thickness Design Manual for Concrete Streets and Local Roads EB109
- Equivalent Pavement Design Charts

What’s Equivalent
**Equivalent Pavement Design**

### Equivalency Chart
For Concrete and Asphalt Pavements

Concrete and asphalt pavements are not only made of different materials, but they also carry traffic loads in entirely different ways. This means that the thickness design procedures for concrete and asphalt pavements are also different. The structural number concept has, however, been used to estimate concrete and asphalt pavement sections.

The concept of layer coefficients was developed during the road test conducted by the American Association of State Highway Officials (AASHO), to account for all of the materials and layers in an asphalt pavement structure.

In the 1960s, shortly after the AASHO Road Test was complete, satellite studies in Louisiana prepared that anticipated existing concrete pavement that is overlaid with asphalt has a structural coefficient of approximately 0.50. This value has since been often cited in some older design manuals. In reality, this is a conservative value, which can be used to estimate comparable pavement sections.

The following table lists layer coefficients for various materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>Layer Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>0.50</td>
</tr>
<tr>
<td>Asphalt Surface</td>
<td>2.0 + 0.48 - 0.80</td>
</tr>
<tr>
<td>Plantmix (high stability)</td>
<td>0.56 - 0.44</td>
</tr>
<tr>
<td>Roadtix (low stability)</td>
<td>0.16 - 0.20</td>
</tr>
<tr>
<td>Sand Asphalt</td>
<td>0.30 - 0.40</td>
</tr>
<tr>
<td>Bituminous-Treated Base</td>
<td></td>
</tr>
<tr>
<td>Coarse-Graded Base</td>
<td>0.10 - 0.94</td>
</tr>
<tr>
<td>Sand Asphalt</td>
<td>0.10 - 0.30</td>
</tr>
<tr>
<td>Cement-Treated Base (by compressive strength)</td>
<td></td>
</tr>
<tr>
<td>&gt; 650 psi</td>
<td>0.25</td>
</tr>
<tr>
<td>400 - 650 psi</td>
<td>0.20</td>
</tr>
<tr>
<td>&lt; 400 psi</td>
<td>0.15</td>
</tr>
<tr>
<td>Non-Stabilized Base</td>
<td></td>
</tr>
<tr>
<td>Lime Treated</td>
<td>0.10 - 0.15</td>
</tr>
<tr>
<td>Crushed Stone</td>
<td>0.10 - 0.14</td>
</tr>
<tr>
<td>Sandy Gravel</td>
<td>0.07</td>
</tr>
</tbody>
</table>

*Used for estimating purposes only.

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**Residential**

Design variables:
- $k = 100$, $ADT = 5$
- Light axle load category, 20 year design life, unreinforced, 600 psi concrete flexural strength

Concrete: Design thickness $= 6.0$ inches

Asphalt: 1.5 inches high stability asphalt on a course-graded bituminous base of 7.0 inches

**Collector**

Design variables:
- $k = 100$, $ADT = 50$
- Medium axle load category, 50 year design life, unreinforced, 600 psi concrete flexural strength

Concrete: Design thickness $= 7.0$ inches

Asphalt: 1.5 inches high stability asphalt on a course-graded bituminous base of 10.5 inches

**Minor Arterial**

Design variables:
- $k = 200$, $ADT = 500$
- Heavy axle load category, 30 year design life, domed, unreinforced, 600 psi concrete flexural strength

Concrete: Design thickness $= 8.0$ inches

Asphalt: 1.5 inches high stability asphalt on a course-graded bituminous base of 12.0 inches

**Major Arterial**

Design variables:
- $k = 200$, $ADT = 1900$
- Very heavy axle load category, 30 year design life, domed, unreinforced, 600 psi concrete flexural strength

Concrete: Design thickness $= 9.0$ inches

Asphalt: 1.5 inches high stability asphalt on a course-graded bituminous base of 15.0 inches

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Design Aids
The latest design and cost analysis tool from ACPA…

- Design & compare thickness requirements and costs for concrete and asphalt pavements

- Features:
  - Updated mechanistic design method for concrete pavement
    - Fatigue and erosion analysis
    - Jointing spacing & load transfer recommendations
    - Thickness rounding and reliability considerations
    - Analysis of existing concrete pavements
  - Life cycle cost analysis module
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  - User-friendly format and features
    - Walkthrough Wizard
    - Help information for all inputs
SLR Pavement Design

- Street classification and traffic
- Geometric design
- Subgrades and subbases
- Concrete quality
- Thickness design
- Jointing
- Construction specifications
## Street Class Description

<table>
<thead>
<tr>
<th>Street Class</th>
<th>Description</th>
<th>Two-way Average Daily Traffic (ADT)</th>
<th>Two-way Average Daily Truck Traffic (ADTT)</th>
<th>Typical Range of Slab Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Residential</td>
<td>Short streets in subdivisions and similar residential areas – often not through-streets.</td>
<td>Less than 200</td>
<td>2-4</td>
<td>4.0 - 5.0 in. (100-125 mm)</td>
</tr>
<tr>
<td>Residential</td>
<td>Through-streets in subdivisions and similar residential areas that occasionally carry a heavy vehicle (truck or bus).</td>
<td>200-1,000</td>
<td>10-50</td>
<td>5.0 - 7.0 in. (125-175 mm)</td>
</tr>
<tr>
<td><strong>Collector</strong></td>
<td><em>Streets that collect traffic from several residential subdivisions, and that may serve buses and trucks.</em></td>
<td>1,000-8,000</td>
<td>50-500</td>
<td>5.5 - 9.0 in. (135-225 mm)</td>
</tr>
<tr>
<td>Business</td>
<td>Streets that provide access to shopping and urban central business districts.</td>
<td>11,000-17,000</td>
<td>400-700</td>
<td>6.0 - 9.0 in. (150-225 mm)</td>
</tr>
<tr>
<td>Industrial</td>
<td>Streets that provide access to industrial areas or parks, and typically carry heavier trucks than the business class.</td>
<td>2,000-4,000</td>
<td>300-800</td>
<td>7.0 - 10.5 in. (175-260 mm)</td>
</tr>
<tr>
<td>Arterial</td>
<td>Streets that serve traffic from major expressways and carry traffic through metropolitan areas. Truck and bus routes are primarily on these roads.</td>
<td>4,000-15,000 (minor) 4,000-30,000 (major)</td>
<td>300-600 700-1,500</td>
<td>6.0 - 9.0 in. (150-225 mm) 7.0 - 11.0 in. (175-275 mm)</td>
</tr>
</tbody>
</table>
Geometric Design

- Utilities
- Increase Edge Support
  - Integral Curb
  - Tied Curb & Gutter
  - Widened Lanes (2 feet no parking)
  - Parking Lanes
  - Rural Areas – Tied Concrete Shoulders

- Street Widths
  - Minimum width of 25 ft.
  - Maximum Cross Slope of 2 percent (¼” per ft.)
  - Traffic Lanes 10-12 feet
  - Parking Lanes 7-8 feet
Subbase vs. NO Subbase

For Concrete Pavements
Subbase vs. NO Subbase

- Heavy Traffic?? > 120 Trucks/day = subbase
- Fine grain soils prone to erosion
- Presence of moisture/water
  - Potential pumping

Presence of all above conditions suggests need for subbase
Subgrade and Subbases
For Concrete Pavements
Subgrade and Subbases

**Subgrade**
- Natural ground, graded, and compacted on which the pavement is built.

**Subbase**
- Layer of material directly below the concrete pavement.
UNIFORMITY:
The Key To
GOOD
PAVEMENT
PERFORMANCE
Design for Uniform Support

Three Major Causes for Non-Uniform Support

- Expansive Soils
- Differential Frost Heave
- Pumping (loss of support)
Subbase vs. NO Subbase

- Presence of fine-grained soil
- Presence of water
- Sufficient volume of trucks to cause soil pumping (> 100 trucks/day)
- Pavements on > 15% grade
Subgrade Properties

Modulus of Subgrade Reaction, k-value

\[ k = \frac{\text{Plate load on subgrade}}{\text{Plate deflection on subgrade}} \]

\[ k = \frac{5.0 \text{ psi}}{0.5 \text{ in}} = 100 \text{ psi/in.} \]
Subgrade Properties

- Plate-load test is rarely performed
  - time consuming & expensive

- Estimate k-value by correlation to other tests
  - e.g. California Bearing Ratio (CBR) or R-value tests

- Lean concrete subbases increases k-value substantially
## Subgrade Properties

### Correlated k-values for Subgrade Support

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount of Support</th>
<th>Historical k-values (pci)</th>
<th>California Bearing Ratio (CBR), % (ASTM D 1183)</th>
<th>Resistance Value (R-value) (ASTM D 2844)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine-grained with high amounts of silt/clay</td>
<td>Low</td>
<td>75 - 120</td>
<td>2.5 - 3.5</td>
<td>10 - 22</td>
</tr>
<tr>
<td>Sand and sand-gravel with moderate silt/clay</td>
<td>Medium</td>
<td>130 - 170</td>
<td>4.5 - 7.5</td>
<td>29 - 41</td>
</tr>
<tr>
<td>Sand and sand-gravel with little or no silt/clay</td>
<td>High</td>
<td>180 - 220</td>
<td>8.5 - 12</td>
<td>45 - 52</td>
</tr>
</tbody>
</table>
Subgrade and Subbases

Design Summary

- Subgrade strength is not a critical element in the thickness design.
  - Has little impact on thickness.
- Need to know if pavement is on:
  - Subgrade (k $\approx 25$ MPa/m (100 psi/in.)),
  - Granular subbase (k $\approx 40$ MPa/m (150 psi/in.)),
  - Asphalt treated subbase (k $\approx 80$ MPa/m (300 psi/in.))
  - Cement treated/lean concrete subbase (k $\approx 125$ MPa/m (500 psi/in.)).
Subgrade and Subbases

Performance Summary

- Proper design and construction are **absolutely necessary** if the pavement is to perform.
  - Must be **uniform** throughout pavement’s life.
- Poor subgrade/subbase preparation can not be overcome with thickness.
  - Any concrete pavement, built of any thickness, will have problems on a poorly designed and constructed subgrade or subbase.
Subbase Effects

At the AASHO Road Test, concrete pavements with granular bases could carry about 30% more traffic.

The current design procedures allow concrete pavements built with granular bases to carry about 5 - 8% more traffic.
Drainable Subbase??

- Aggregate Quality – marginal D-cracking?
- Traffic Level – high volume may warrant drainable subbase
- Edge drains behind curb still good detail
Basics of Thickness Design
Biggest Impact on Thickness Design

- Concrete Strength
- Joint Spacing
- Edge Support
- CTE – Coefficient of Thermal Expansion
- Reliability
The latest design and cost analysis tool from ACPA…

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    - Help information for all inputs
Thickness Design for Streets and Local Roads

StreetPave User Inputs & Outputs

- Global Settings
  - Region
  - Units (English or Metric)
  - Terminal Serviceability
  - Percent Slabs Cracked at end of design Life

- Design Life

- Reliability

- Traffic

- Pavement Properties

- Thickness/Dowel/Jointing Recommendations
Design Example – Inputs

- Design life = 30 years
- $k$-value = 100 pci
- Concrete flexural strength = 600 psi
- Load transfer (dowels) = yes
- Edge support = yes
- Traffic category = Collector
- 2-way ADTT = 100
- Reliability = 80%
- Percent Slabs Cracked = 15%
Thickness Design Procedure

Design controlled by:

- Fatigue usually controls design of light-traffic pavements
  - Single-axles usually cause more fatigue damage

- Erosion usually controls design of undoweled medium- and heavy-traffic pavements
  - Tandem-axles usually cause more erosion damage
  - Tridem-axles usually cause more erosion damage
Thickness Design Procedure
Concrete Properties

- **Flexural Strength**
  (Modulus of Rupture, ASTM C 78)
  - Avg. 28-day strength in 3rd-point loading

- **Other Factors**
  - Concrete Strength Gain with Age
  - Fatigue Properties

---

**Third-point Loading**

\[ d = \frac{L}{6} \]

\[ \text{Span Length} = L \]
Concrete Properties

Compressive Strength $f'_c$

$$S'_c = 8-10 \sqrt{f'_c}$$

$f'_c = \text{Compressive Strength (psi)}$

$S'_c = \text{Flexural Strength (psi)}$
Basics of Thickness Design
Stress / Fatigue

- Compressive strength: ~4000 psi
- Flexural strength: ~600 psi
Strength Correlations

\[ MR = 7.5 \times f'c^{0.5} \]
\[ MR = 9 \times f'c^{0.5} \]
\[ MR = 10 \times f'c^{0.5} \]
Comparison of $f'_{c}$, MR, and Required Thickness

<table>
<thead>
<tr>
<th>Compressive Strength (psi)</th>
<th>Flexural Strength (psi)</th>
<th>Design Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>450 – 550 (500)</td>
<td>6.5 (6.43) PCA 7.0</td>
</tr>
<tr>
<td>4000</td>
<td>510 – 630 (600)</td>
<td>5.5 (5.25) PCA 6.5</td>
</tr>
<tr>
<td>5000</td>
<td>570 – 710 (700)</td>
<td>5.0 (4.86) PCA 6.0</td>
</tr>
</tbody>
</table>

Life 30 years, Collector (2), k-value 162, Reliability 80 %, plus C & G, 2 % annual growth
Design Period/Life

- 20 to 35 years is commonly used

- Shorter or longer design period may be economically justified in some cases

  - High performance concrete pavements
  - Long-life pavements
  - A special haul road to be used for only a few years
  - Cross-overs
  - Temporary lanes
Design Reliability

- Practically everything associated with pavement design is variable
  - Variability in mean design inputs—traffic, materials, subgrade, climate, and so on
  - Error in performance prediction models

- Simply Stated, the reliability is the factor of safety of the pavement design

- Level selected depends on type of roadway and expected performance
# Reliability

## Levels of Reliability for Pavement Design

<table>
<thead>
<tr>
<th>Functional Classification of Roadway</th>
<th>Recommended Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interstates, Freeways, and Tollways</strong></td>
<td><strong>Urban</strong></td>
</tr>
<tr>
<td></td>
<td>85 – 99</td>
</tr>
<tr>
<td></td>
<td>90</td>
</tr>
<tr>
<td><strong>Principal Arterials</strong></td>
<td>80 – 99</td>
</tr>
<tr>
<td></td>
<td>90</td>
</tr>
<tr>
<td><strong>Collectors</strong></td>
<td>80 – 95</td>
</tr>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td><strong>Residential &amp; Local Roads</strong></td>
<td>50 – 80</td>
</tr>
<tr>
<td></td>
<td>70</td>
</tr>
</tbody>
</table>
# Thickness Design

## Recommended Levels of Slab Cracking by Roadway Type

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Recommended Percent of Slabs Cracked at End of Design Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Default) INDOT Section 304 Suggested Threshold</td>
<td>15% 10%</td>
</tr>
<tr>
<td>Interstate Highways, Expressways, Tollways, Turnpikes</td>
<td>5% 10%</td>
</tr>
<tr>
<td>State Roads, Arterials</td>
<td>10% 10%</td>
</tr>
<tr>
<td>Collectors, County Roads</td>
<td>15% 10%</td>
</tr>
<tr>
<td>Residential Streets</td>
<td>25% 10%</td>
</tr>
</tbody>
</table>
Effect of k-value on Thickness

Thickness, in.

k-value, psi/in.
Effect of Flexural Strength on Thickness

Modulus of Rupture (Flexural Strength), psi

Thickness, in.
Effect of Reliability (at 15% Slabs Cracked) on Thickness
Slab Cracking at Year 30 vs. Thickness, for 80% Reliability

% Concrete Slabs Cracked

Thickness, in.

Basics of Thickness Design
Deflection / Erosion

- Higher k-value will lower deflections
- Load transfer will lower deflections
Concrete Pavement Design
Deflection/Erosion

Load Transfer (slabs ability to share its load with neighboring slabs)

- Dowels
- Aggregate Interlock
- Edge Support
  - Tied curb & gutter
  - Integral curb & gutter
  - Parking lane
  - Tied concrete

\[ \Delta L = x \]

\[ \Delta U = 0 \]

Poor Load Transfer

\[ \Delta L = x/2 \]

\[ \Delta U = x/2 \]

Good Load Transfer
**Dowels vs. NO Dowels**

**Load Transfer**

The slabs' ability to share its load with its neighboring slab

- **Dowels**
  - High Traffic Volumes
    - (Pavements > 8 in.)
    - (> 120 Trucks/day)

- **Aggregate Interlock**
  - Low Traffic Volumes
    - (Pavements < 7 in.)

\[ \Delta L = x \]
\[ \Delta U = 0 \]

\[ \Delta L = x \quad \text{Good Load Transfer} \]
\[ \Delta U = x \]
# Load Transfer Efficiency

<table>
<thead>
<tr>
<th>Load Transfer Mechanism</th>
<th>LTE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate interlock</td>
<td>30 - 80</td>
</tr>
<tr>
<td>stabilized base</td>
<td>50 - 90</td>
</tr>
<tr>
<td>dowel bars</td>
<td>80 - 95</td>
</tr>
</tbody>
</table>
Aggregate Interlock

Shear between aggregate particles below the initial saw cut
Aggregate Interlock
Design - Erosion

Conditions for Pumping

- Subgrade soil that will go into Suspension
- Free water between slab and subgrade
- Frequent heavy wheel loads / large deflections
Dowel bars

- Lengths from 15-18 in.
- 6.0 in. min. embedment length
- Diameter
  - 1.00 - 1.25 in. for SLR
- Epoxy or other coating used in harsher climates for corrosion protection
Dowel Recommendations

- Dowels recommended when ADTT is greater than or equal to 120:
  - If pavement thickness is 6” or less, dowels not recommended
  - If pavement thickness is 6.5” to 7.5”, use 1” dowels
  - If pavement thickness is 8” or greater, use 1 1/4” – 1 1/2” dowels
Faulting Model

![Graph showing faulting model for different base conditions and dowels.

- **Dense-graded base**
  - No dowel
  - 1-in dowel
  - 1.25-in dowel

- **Permeable base**
  - No dowel

Traffic, million ESALs:

Faulting, in:

- 0.00
- 0.05
- 0.10
- 0.15
- 0.20

0 5 10 15 20
Construction of Concrete Pavement

- Plant Operations
- Central Mixed Concrete
- Plant Operations
- Truck Mixed Concrete
- Paving Operations
- Slipform Paving
- Paving Operations
- Fixed Form Paving
- Saw & Seal

Central Mix Concrete Batch Plant
Construction Specifications

- **Smoothness**
  - 10-20 ft. Straightedge
  - Profilograph Index

- **Texture**
  - Speeds less than 40 mph
    - Burlap Drag
    - Astroturf Drag
    - Tined Surface
Curing

- Curing is one of the most important steps in quality concrete construction and one of the most neglected.

- Effective curing is absolutely essential for surface durability.
Membrane Curing of Concrete

Evaporation from water surface

Partially saturated

Saturated

Curing membrane

Concrete
Curing

- The simplest, most economical and widely used method is a liquid membrane which is sprayed on the surface of a slab as soon as possible after finishing.
- Apply at manufacture’s rate of coverage.
- Perform field check to verify application rate.
Effect of Adequate Curing on Hardened Concrete

Increased
- Strength
- Watertightness
- Abrasion resistance
- Freeze-thaw resistance
- Volume stability
Effect of Curing on Strength Development

- Moist-cured entire time
- In air after 28 days moist curing
- In air after 7 days moist curing
- In laboratory air entire time
Durability = Performance

- Quality Materials
  - Aggregate – AP Approved, uniform gradation
  - Minimum Cement Content
  - Approved Admixtures
- Proper Mix Design – Control to Design
- Moisture/Water Control < 0.45 w/c
- Air Entrainment – 6% ± 1.5%
- Proper Curing – Liquid membrane applied @ manufacturer’s suggested rate
Jointing

- Spacing based on thickness
  - 6” thick – 12’ joint spacing
  - ^’-12” – 15’ joint spacing
  - > 12” thick – 18’ joint spacing
- > 12” thick - saw 1/3 the depth
- High volume traffic – seal joints with silicone or neoprene
- Low volume traffic – seal joints with hot pour rubberized asphalt

What about unsealed joints??
Rehabilitation Strategies

- Three categories:
  - Restoration
  - Resurfacing
  - Reconstruction

  Together, known as CPR³

- Which is used depends on existing condition.
Rehabilitation Timing

- Restoration
- Resurfacing
- Reconstruction

Min. Acceptable Rating

Structural/Functional Condition vs. Age or Traffic
Restoration Techniques

Concrete Pavements

- Full-depth repair
- Partial-depth repair
- Diamond grinding
- Joint & crack resealing
- Slab stabilization
- Retrofitting dowels
- Retrofitting concrete shoulders
- Cross-stitching long. cracks/joints
Overlay vs. Reconstruct

- **Expected Performance**
  - UTW (3” – 5”) – 10 to 15 years
  - Thicker overlays (6” – 12”) 15 to 25 years
  - Reconstruction – 25 to 30 years

- **Condition of existing pavement**

- **Clearance issues** – if none can build on top of old PCCP or HMA pavement
PCCP Overlay Design Advancements
ACPA Application Library

Welcome to ACPA’s online application library. Here you will find a collection of web- and desktop-based applications created to assist you in the design, construction, and analysis of concrete pavements.

ACPA Members and customers of affiliated ACPA Chapter/State Paving Associations:
Visit ACPA’s Concrete Pavement Resource Center to search and browse a collection of over 1,000 concrete pavement related technical references published by ACPA, FHWA, IPRF, IGGA, CP Tech Center, and other Industry groups.

Note: There is a known compatibility issue with Internet Explorer 10. To mitigate the issue, please run IE10 in compatibility mode or download and use Google Chrome.
Design Aid

Background

This bonded concrete overlay on asphalt (BCOA) thickness design web application is based primarily on the results of FHWA-ICT-08-016, "Design and Concrete Material Requirements for Ultra-Thin Whitetopping", a research project conducted in cooperation with the Illinois Center for Transportation at the University of Illinois (ICT), the Illinois Department of Transportation (IDOT), and the Federal Highway Administration (FHWA). The web application reflects the views of the ACPA, who is responsible for the facts and accuracy of the data presented within it. The contents do not necessarily reflect the official views or policies of ICT, IDOT, or FHWA, and this application does not constitute a standard, specification, or recommendation. Designers should understand the assumptions/limitations of the research on which this tool is based and also be knowledgeable about the various types of concrete overlay offerings and design/construction details of each type.

Acknowledgements

General Design Details

- Design Lane ESALs: 0
- Slabs Cracked at End of Design Life (%): 20%
- Rollability (%): 85%
- Location: AL, Birmingham

Existing Pavement Structure Details

- Remaining Asphalt Thickness (in.): 4
- Asphalt Modulus of Elasticity (psi): 350,000
- Modulus of Subgrade Reaction (pci): 150

Concrete Material Details

- Average 28-Day Flexural Strength (psi): 750
- Macrofibers in Concrete: No
- Concrete Modulus of Elasticity (psi): 3,600,000
- Coefficient of Thermal Expansion ($10^{-6}$/°F): 5.5

Concrete Overlay Details
### General Information

- **Latitude (degree):** 44.53
- **Longitude (degree):** -93.14
- **Elevation (ft):** 874
- **Estimated Design Lane ESALs:** 1000000
- **Maximum Allowable Percent Slabs Cracked (%):** 25
- **Desired Reliability against Slab Cracking (%):** 85

### Climate

- **AMAT Region ID:** 5
- **Map of Sunshine Zone:** 2

### Existing Structure

- **Post-milling HMA Thickness (in):** 6
- **HMA Fatigue:**
  - **Composite Modulus of Subgrade Reaction, k-value (psi/in):** 150
  - **Example of Fatigue Cracking**
  - **k-value Calculator**
islab2000

New Tools for New Problems

EverFE
Other Design Developments
Guide to Concrete Overlays
Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements

A practical approach to understanding and successfully using concrete overlays, from selection to opening

Third Edition expected out in Spring 2014
The National Concrete Overlay Explorer

Instructions

MAP VIEW • TABLE VIEW • DETAILS VIEW

540 items

61 results out of 540 cannot be plotted.
Family of Concrete Overlays

Concrete Overlays

Bonded Resurfacing Family

- Bonded Concrete Resurfacing of Concrete Pavements
- Bonded Concrete Resurfacing of Asphalt Pavements
- Bonded Concrete Resurfacing of Composite Pavements

Unbonded Resurfacing Family

- Unbonded Concrete Resurfacing of Concrete Pavements
- Unbonded Concrete Resurfacing of Asphalt Pavements
- Unbonded Concrete Resurfacing of Composite Pavements
Unbonded Overlay

- Consists of thick concrete layer (125 mm or greater) on top of an existing concrete.
- Uses a “separation interlayer” to separate new overlay and existing concrete.
9” PCCP over old Chip & seal road
Allisonville Road

7” – 11” PCCP over 2 lane HMA street
Bremen Highway – St. Joseph County

4.0 “ PCCP Inlay
SR 161 – Dubois County

6.0 “PCCP Overlay of Existing HMA Pavement
CR 275W – Cass County

6.5” Unbonded PCCP Overlay of 50+ year old PCCP
Full Depth Repairs

- Repairs distresses greater than 1/3 the slab depth.
- Consists of removing and replacing at least a portion of the existing slab to the bottom of the concrete.
Partial Depth Repairs

- Repairs deterioration in the top 1/3 of the slab.
- Generally located at joints, but can be placed anywhere surface defects occur.
Carbide-Milling

Longitudinal Milling

Transverse or Longitudinal Joint/Crack

Near vertical edges.

Transverse Milling (Half-moon)

Transverse or Longitudinal Joint/Crack
REMOVAL

Milling
TYPICAL MILLED AREA
CURING

- Use curing compound
Diamond Grinding

- Improves ride by removing:
  - Faulting at joints
  - Slab warping
  - Surface deformations caused by studded tires
- Reestablishes skid resistance
- Corrects cross-slope
ACPA Application Library

Welcome to ACPA’s online application library. Here you will find a collection of web and desktop-based applications created to assist you in the design, construction, and analysis of concrete pavements.

ACPA Members and customers of affiliated ACPA Chapter/State Paving Associations:
Visit ACPA’s Concrete Pavement Resource Center to search and browse a collection of over 1,000 concrete pavement related technical references published by ACPA, FHWA, IPRF, IGGA, CP Tech Center, and other Industry groups.

Note: There is a known compatibility issue with Internet Explorer 10. To mitigate the issue, please run IE10 in compatibility mode or download and use Google Chrome.
SLR Publications

**Information Sheet**

*Maturity Testing of Concrete*

**Information Sheet** - (IS) Concrete Pavement for GA Business & Commuter Aircraft

**Information Sheet** - Longevity and Performance of DG Pavements

**Information Sheet** - Specification Guideline for Dowel Bar Retrofit

**Engineering Bulletin**


www.pavement.com
Indiana Concrete Resources

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Thank You