

Using the BCOA- ME Guide

Bonded Concrete Overlay of Asphalt Pavements
Mechanistic-Empirical Design Guide (BCOA – ME)



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FHWA Pooled Fund Study TPF 5-165





Instruction:

Select from drop-down list; Enter data; Enter data or use calculation.
(Please enable the Macros and the Internet Explorer (not mandatory) to run the spreadsheet.)

General Information

Latitude (degree):	44.5
Longitude (degree):	-93.1
Elevation (ft):	874
Estimated Design Lane ESALs:	1,000,000
Maximum Allowable Percent Slabs Cracked (%):	25%
Desired Reliability against Slab Cracking (%):	85%

Geographic Information

ESALs Calculator

Climate

AMDAT Region ID	5
Sunshine Zone	2

Existing Structure

Post-milling HMA Thickness (in):	6
HMA Condition (Fatigue cracking in the HMA):	Adequate
Composite Modulus of Subgrade Reaction, k-value (psi/in):	150
Does the existing HMA pavement have nondeteriorated transverse cracks?	Yes

Examples

k-value Calculator

Transverse Cracking

PCC Overlay

Average 28-day flexural (third point) strength (psi):	650
Estimated PCC Elastic Modulus (psi):	4,000,000
Coefficient of Thermal Expansion (10 ⁻⁶ in ² /F/in)	5.5
Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected)	0.0

Epcc Calculator

CTE Calculator

Joint Design

Joint Spacing (transverse x longitudinal, ft x ft):	6 x 6
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Calculate Design

Performance Analysis

Calculated PCC Overlay Thickness (in): 3.84
 Design PCC Overlay Thickness (in): 4.0
 Is there potential for reflective cracking? Yes.

Solved.



General Information: Traffic

Level 1

Estimated Design Lane ESALs:

10,000,000

ESALs Calculator

ESALs Estimation:

Is One-Way ADT available?

Yes

No

Cancel

Level 2

Estimate ESALs:

Design Life (yrs):	10
Terminal Serviceability:	2
Number of Lanes in Each Direction:	1
Percent Trucks(%):	6
ADTT Growth Rate (%):	3
Traffic Growth Rate Type:	Non linear
Road Category:	Collector
One-Way Average Daily Traffic (ADT):	5,000

Submit

Cancel

Level 3

Estimate ESALs:

Design Life (yrs):	10
Terminal Serviceability:	2
Number of Lanes in Each Direction:	1
Percent Trucks(%):	6
ADTT Growth Rate (%):	3
Traffic Growth Rate Type:	Non linear
Road Category:	Collector

Submit

Cancel

General Information: Location

Latitude (degree):	44.5
Longitude (degree):	93.1
Elevation (ft):	874

Geographic Information

Geographic Information

Option 1

Visit Link in Internet Explorer

Open Webpage

Or

Option 2 **Level 2**

Closest Location:

MINNEAPOLIS, MN

Submit

Cancel

Level 1

map, latitude/lon: x

veloroutes.org/elevation/?location=Minneapolis&units=e

units: feet Find elevation

Elevation for Minneapolis is 859 feet

- The latitude for this location is: 44.979965
- The longitude for this location is: -93.263836
- Click [here](#) to create a route at this location...

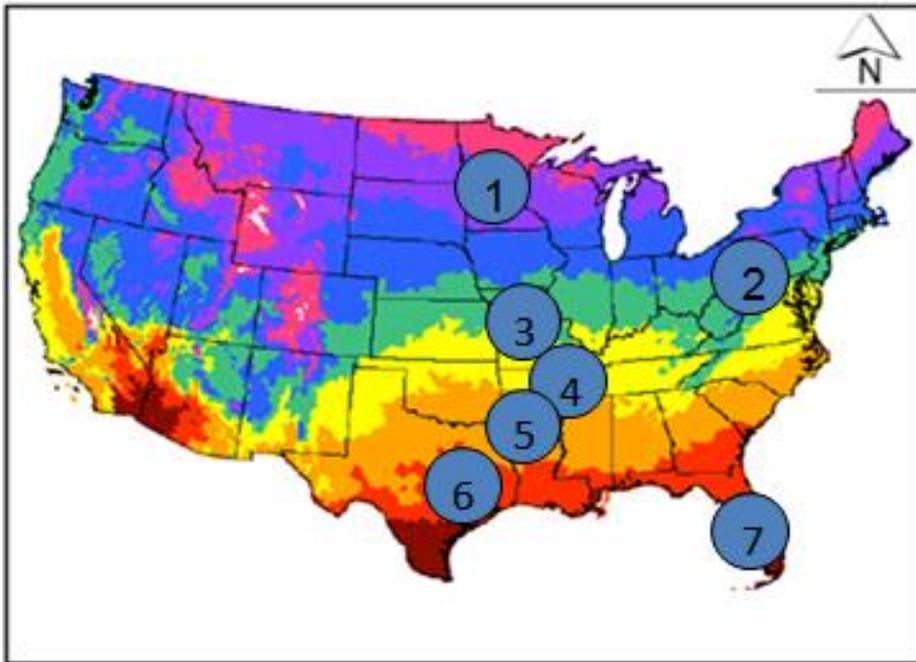
Map Satellite Hybrid Terrain

Longitude Technology
Enhanced parimutuel capabilities for the wagering industry
www.longitude.com

Climate: Temperature region

Climate	
AMDAT Region ID	5
Sunshine Zone	2

AMDAT = Annual mean daily average temp.



Region ID	Color code	AMDAT (°F)
1		32.0-45.0
2		45.1-50.0
3		50.1-55.0
4		55.1-60.0
5		60.1-65.0
6		65.1-70.0
7		>70.0

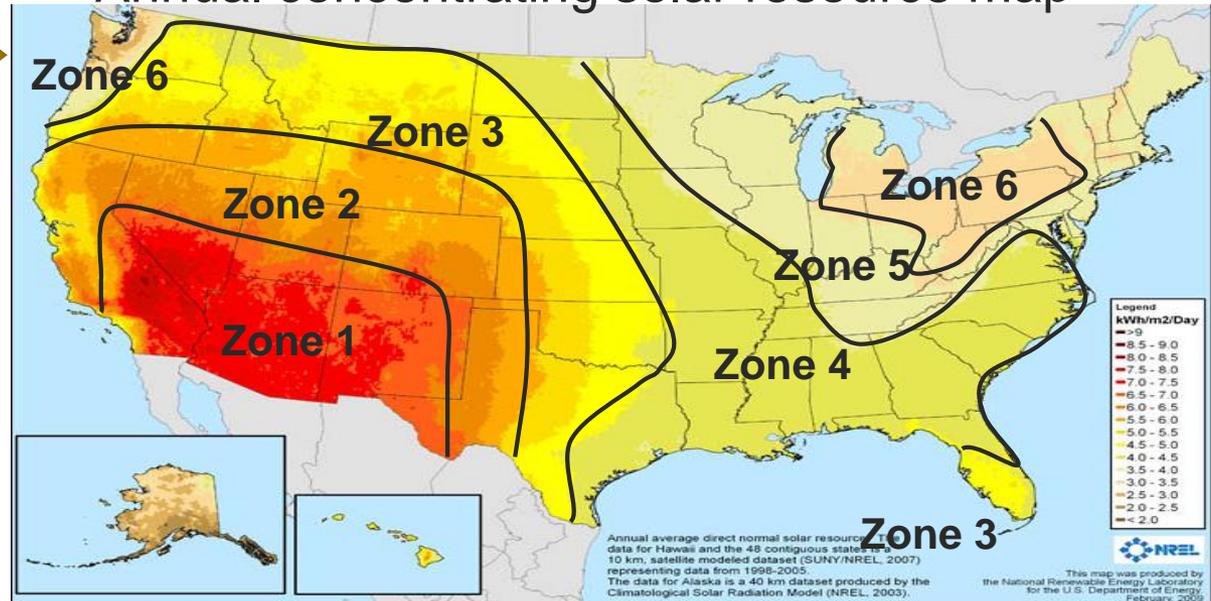
(<http://cdo.ncdc.noaa.gov/climaps/temp0313.pdf>,
accessed on January, 2010).

Climate: Sunshine zones

Climate

AMDAT Region ID	5
Sunshine Zone	2

Annual concentrating solar resource map



(<http://www.nrel.gov/gis/solar.html>, as in May 2010)

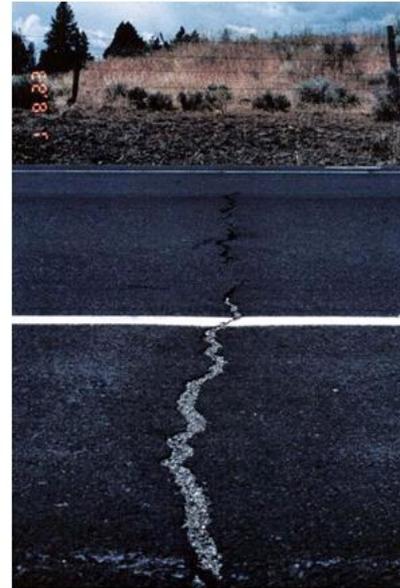
Fig. 4 Transverse Cracking

(a) Transverse cracking in an existing HMA pavement (non-deteriorated)



(MnROAD, 1997)

(b) Transverse cracking in an an existing HMA pavement (deteriorated)



(<http://www.pavementinteractive.org/article/transverse-cracking/>)

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Existing Structure: E_{HMA}

Post-milling HMA Thickness (in):	6
HMA Condition:	Adequate
Composite Modulus of Subgrade Reaction, k-value (psi/in):	150
Does the existing HMA pavement have temperature cracks?	No

PCC Overlay

Average 28-day Flexural Strength (psi):	650
Estimated PCC Elastic Modulus (psi):	4,000,000

Category	Fatigue Cracking
Adequate	0% - 8%
Marginal	8% - 20%

Epcc Calculator



% surface area with fatigue cracking

Existing structure: E_{HMA} Examples

Existing Structure

Post-milling HMA Thickness (in):	6	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Examples k-value Calculator Transverse Cracking </div>
HMA Condition (Fatigue cracking in the HMA):	Adequate	
Composite Modulus of Subgrade Reaction, k-value (psi/in):	150	
Does the existing HMA pavement have nondeteriorated transverse cracks?	Yes	

Fig. 3 Examples of fatigue cracking in HMA pavement

Description

Fatigue cracking is found in areas subjected to repeated traffic loadings (wheelpaths). It can appear as a series of interconnected cracks in the early stages of development. It ultimately develops into many-sided, sharp-angled pieces, characteristically with an alligator pattern, in later stages. (*Distress Identification Manual for The LTPP*. FHWA, 2003)

Severity Levels

(a) Adequate

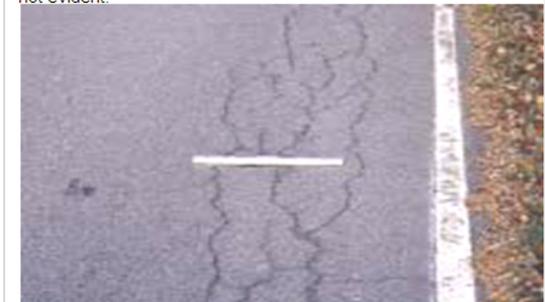
Wheelpath cracking has only a few connecting cracks; cracks are not spalled or sealed; pumping is not evident.



(<http://www.pavementinteractive.org/wp-content/uploads/2008/08/WSDOT062.jpg>)

(b) Marginal

Wheelpath cracks are interconnected and form a complete pattern; cracks may be slightly spalled or sealed; pumping is not evident.



Distress Identification Manual for The LTPP. FHWA, 2003)

Existing Structure: k-value

Existing Structure

Post-milling HMA Thickness (in):	6
HMA Condition:	Adequate
Composite Modulus of Subgrade Reaction, k-value (psi/in):	200
Does the existing HMA pavement have temperature cracks?	Yes

k-value Calculator

Subgrade k-Value Calculator

apps.acpa.org/apps/kValue.aspx

ACPA

Description

The k-Value is a commonly applied value in concrete pavement design. It estimates the composite of support of any subgrade(s) or subbase(s) layers below the concrete pavement surface course. This web applet allows you to determine the composite k-Value with consideration for up to three subgrade/subbase layers. The conversion from resilient modulus of the subgrade to k-value was updated in the fall of 2011 to better reflect published test results; the constant conversion factor of 19.4 as suggested in the AASHTO Guide for Design of Pavement Structures 1993 is no longer used. The conversion from resilient modulus of the subgrade to k-value was

Step 1 - Calculate Subgrade k-Value

Resilient Modulus of Subgrade (M_{RSG}):

[Calculate Resilient Modulus](#)

k-Value corresponding to the calculated M_{RSG} :

Step 2 - Calculate Composite k-Value

From the top down, input subgrade/subbase details

Number of subgrade/subbase layers:

Existing Structure: k-value

Whitetopping

$E = \text{HMA}$

$k_{\text{composite}} = \text{All granular layers}$



Composites

No bond @ old HMA/old PCC interface

$E = \text{HMA}$

$k_{\text{composite}} = \text{old PCC} + \text{All granular layers}$



Bond @ old HMA/old PCC interface

$E = \text{HMA} + \text{old PCC}$

$k_{\text{composite}} = \text{All granular layers}$



Existing structure: Transverse cracking

Existing Structure

Post-milling HMA Thickness (in):	6	Examples k-value Calculator Transverse Cracking
HMA Condition (Fatigue cracking in the HMA):	Adequate	
Composite Modulus of Subgrade Reaction, k-value (psi/in):	150	
Does the existing HMA pavement have nondeteriorated transverse cracks?	Yes	

Fig. 4 Transverse Cracking

(a) Transverse cracking in an existing HMA pavement (non-deteriorated)



(MnROAD, 1997)

(b) Transverse cracking in an existing HMA pavement (deteriorated)



(<http://www.pavementinteractive.org/article/transverse-cracking/>)

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PCC Overlay: Strength & stiffness

Internally estimates E_{pcc} based on either:

Compressive strength **Flexural strength**

PCC Overlay

Average 28-day Flexural Strength (psi):	700
Estimated PCC Elastic Modulus (psi):	4,000,000
Coefficient of Thermal Expansion (10^{-6} in ³ F/in)	5.5
Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	0

E_{pcc} Calculator

CTE Calculator

PCC Overlay

Average 28-day Compressive Strength (psi):	5,000
Estimated PCC Elastic Modulus (psi):	4,000,000
Coefficient of Thermal Expansion (10^{-6} in ³ F/in)	5.5
Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	0

E_{pcc} Calculator

CTE Calculator



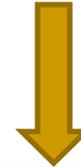
CTE

PCC Overlay

Average 28-day Flexural Strength (psi):	700
Estimated PCC Elastic Modulus (psi):	4,000,000
Coefficient of Thermal Expansion (10^{-6} in/ $^{\circ}$ F/in)	5.5
Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	0

Ecc Calculator

CTE Calculator



CTE Estimator:

Type of Coarse Aggregate: Gravel

Recommended Value of the Thermal Coef. of PCC as a Function of Agg. Types

Type of Coarse Aggregate	Concrete Thermal Coef. ($10e-6/^{\circ}$ F)
Quartz	6.6
Sandstone	6.5
Gravel	6.0
Granite	5.3
Basalt	4.8
Limestone	3.8

Submit

Cancel

(AASHTO 93, pp II-29)

PCC Overlay: Fiber content

Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	0

Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	No Fibers Synthetic Structural Fibers Steel Fibers Low Modulus Synthetic
Joint Design	
Joint Spacing (ft):	

Select type from
drop-down list

Joint spacing

Joint Design

Joint Spacing (transverse x longitudinal, ft x ft):

2 x 2
3 x 3
4 x 4
6 x 6
7 x 7
10 x 12
12 x 12
15 x 12

Select size from drop-down list

Design thickness

PCC Overlay

Average 28-day Flexural Strength (psi):	700
Estimated PCC Elastic Modulus (psi):	4,000,000
Coefficient of Thermal Expansion (10^{-6} in/ $^{\circ}$ F/in)	5.5
Fiber Type:	No Fibers
Fiber Content(lb/cu yd) (Only used when a fiber type is selected):	0

Epsc Calculator

CTE Calculator

Joint Design

Joint Spacing (ft):	6
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Calculate Design

Performance Analysis

Calculated PCC Overlay Thickness (in): 3.21

Design PCC Overlay Thickness (in): 3.5

Is there potential for reflective cracking? Yes

Solved.