Pavement Design for Practitioners - PAVEXpress

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ND DOT

Amy Miller, P.E.
Asphalt Pavement Alliance

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

SAPA
State Asphalt Pavement Associations

ASPHALT INSTITUTE

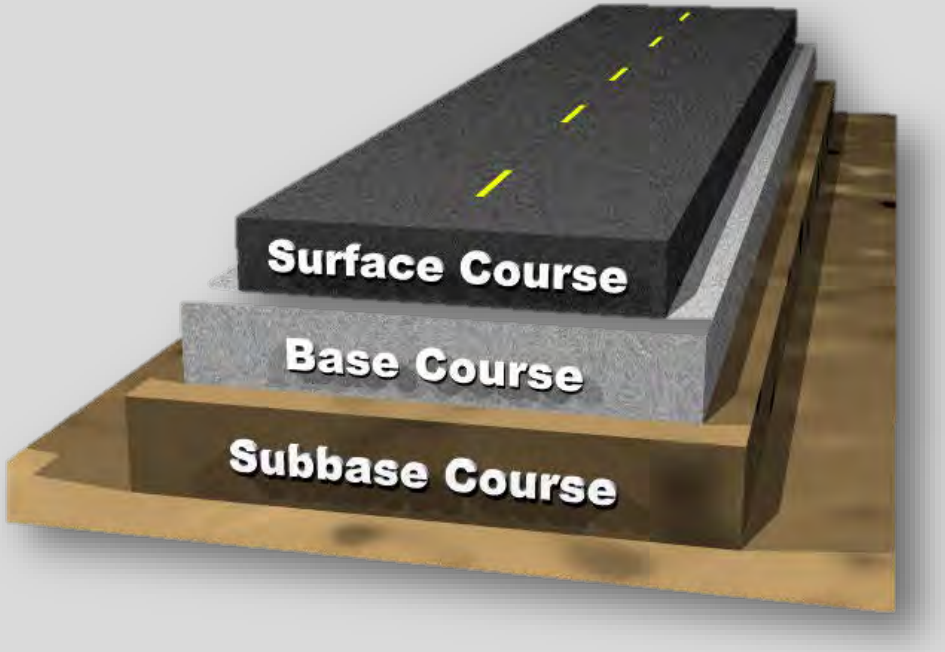
APA ASPHALT PAVEMENT ALLIANCE

The Asphalt Pavement Alliance (APA) is a coalition of the Asphalt Institute, the National Asphalt Pavement Association, and the State Asphalt Pavement Associations.


PAVEXpress
A Simplified Pavement Design Tool
www.PAVEXpressDesign.com

Brief Overview

- Why PaveXpress?
- What Is PaveXpress?
- An Introduction
- Overview of the System
- Recent Additions
- New Learning Module



AASHTO has been developing MEPDG for high volume roads, but a gap has developed for local roads and lower volume roads.

What Is PAVEXpress?

A free, online tool to help you create simplified pavement designs using key engineering inputs, based on the AASHTO 1993 and 1998 supplement pavement design process.

- Accessible via the web and mobile devices
- Free — no cost to use
- Based on AASHTO pavement design equations
- User-friendly
- Share, save, and print project designs
- Interactive help and resource links

What Does PaveXpress Do?

- New pavement designs – asphalt and concrete
- Asphalt overlay designs
- Initial cost estimates
- Life cycle cost analysis
- Mechanistic pavement analysis
- Porous pavement design

Verified

- Verified by Gary Sharpe, P.E. of Palmer Engineering
- Asphalt design verified by Kansas DOT
- Used by DOTs, cities, county and private engineers around the country

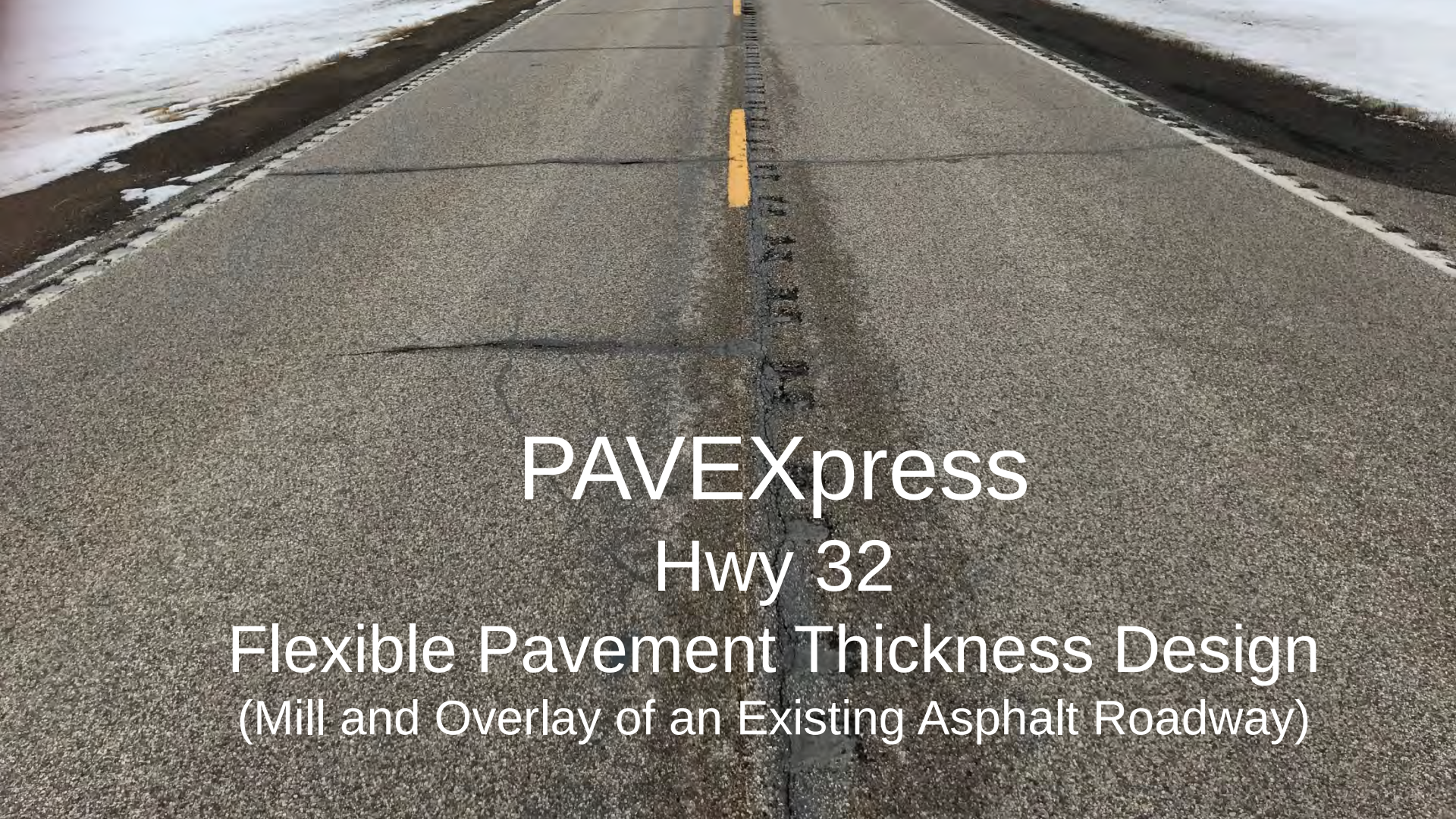
PAVEXpress Examples

1. Overlay
2. New Construction

PaveXpress for AC Overlay Design

- AC Overlay Design for Flexible Pavement Rehabilitation Only
- Evaluation Methods for Existing AC Pavement
  - Condition Survey
  - Non-Destructive Deflection Testing
- Includes Questions on Coring and Milling
  - Delamination/Stripping
  - Top-Down or Bottom-Up Cracking
- Adjustment to Existing Pavement Layer Coefficients

Overlay Example

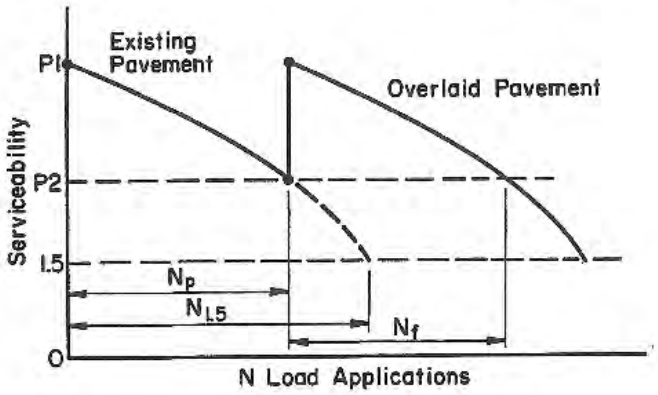


PAVEXpress

Hwy 32

Flexible Pavement Thickness Design

(Mill and Overlay of an Existing Asphalt Roadway)



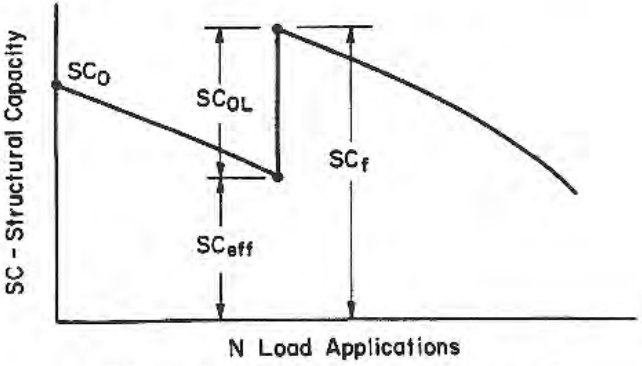


Figure 5.1. Illustration of Structural Capacity Loss Over Time and with Traffic

PAVE

Information Obtained for the Hwy 32 design

- Pavement coring
- Falling Weight Deflectometer analysis
- Linear soils survey
- Average daily traffic and Design ESAL’s
- Evaluation of present serviceability of the roadway
- Distress survey
- Ride data
- Grading Plans
- Pavement Management Data

Condition Survey Method

PAVI

PAV

PAV

PAVE

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Pavement Coring

PAV

Overlay Design Inputs

Reliability 80%

Initial Serviceability 4.5

Terminal Serviceability 2.5

Design ESAL's 1,000,000

Analysis Period 20 years

Subgrade Resilient Modulus (M_r)
5,000 psi

Soil Type A-7-6

Layer Coefficients

- Superpave FAA 43
  0.36
- Existing HBP
  0.25
- Emulsified Base
  0.10 - 0.20
- Aggregate Base CL 5
  0.10

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Print

SCENARIO INFORMATION | PAVEMENT LAYERS | CONDITION SURVEY | LANE CONFIGURATIONS | DESIGN PARAMETERS | TRAFFIC LOADING | DESIGN SUMMARY

Scenario Information

Scenario Information

Scenario Name

Hwy 32 Mill and HBP Overlay

Scenario Description

Condition Survey Option

State

North Dakota

Pavement Design

Estimated Completion Year

2019

Roadway Classification

Arterials/Highway

Project Type

AC Overlay on Asphalt

Structural Evaluation Method

Condition Survey

Next

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PAVEMENT LAYERS

Pavement Layers

Existing Pavement Layers

Layer Type	Thickness	Action?
Asphalt - Dense Graded	7 in.	
Bituminous treated base	3.5 in.	
Aggregate Base	3.5 in.	

Add Layer

Subgrade

Subgrade Soil Type

A-7-6

Subgrade Modulus (M_R)

5000 psi Calculate

New AC Overlay

Layer Coeff. (a)

0.36

Minimum Thickness

0

Previous Next Save

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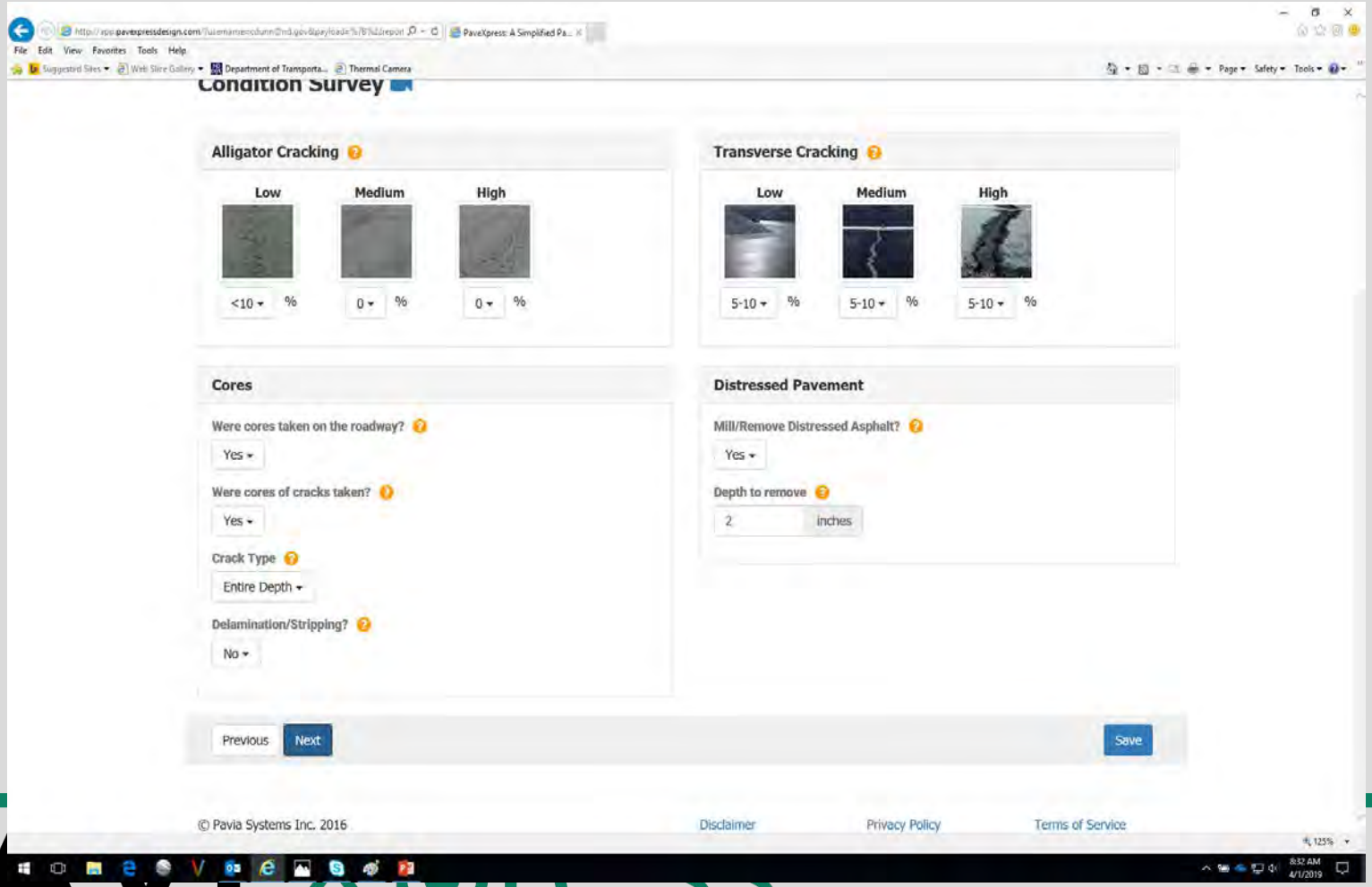
Condition Survey
Alligator Cracking
Low
Medium
High
<10 %
0 %
0 %
Transverse Cracking
Low
Medium
High
5-10 %
5-10 %
5-10 %
Cores
Were cores taken on the roadway?
Yes
Were cores of cracks taken?
Yes
Crack Type
Entire Depth
Delamination/Stripping?
No
Distressed Pavement
Mill/Remove Distressed Asphalt?
Yes
Depth to remove
2
inches
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Next
Save
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LAYER COEFFICIENTS

Layer Coefficients

Layers

Layer Type	Existing Thickness	AASHTO Recommendation	Layer Coef. (a)	Drainage Coef. (m)	SN
Asphalt - Dense Graded	7"	0.20 to 0.30	0.25	1	1.8
Bituminous treated base	3.5"	0.15 to 0.20	0.2	1	0.7
Aggregate Base	3.5"	0.00 to 0.1	0.1	1	0.4

SN_{eff} 2.8

⚠ You have elected to remove 2 inches of pavement from the surface. This may impact the layer coefficient you select.

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DESIGN PARAMETERS

Design Parameters

Design Parameters

Design Period: 20 years

Reliability Level (R): 80 — Z_R = -0.841

Combined Standard Error (S_o): 0.5

Serviceability

Initial Serviceability Index (p_i): 4.5

Terminal Serviceability Index (p_t): 2.5

Change in Serviceability (ΔPSI): 2.00

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TRAFFIC & LOADING

Traffic & Loading

Traffic Data

Method of Determining ESALs

Using AADT | Annual ESALs | Design ESALs

Traffic Growth

Total Design ESALs (W_{18})

1,000,000

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DESIGN GUIDANCE

Guidance

Scoped Design

- Overlay
- Asphalt - Dense Graded
- Bituminous treated base
- Aggregate Base
- Subgrade

Layer Thicknesses (in)

Overlay: 4.2

Asphalt - Dense Graded: 5

Bituminous treated base: 3.5

Aggregate Base: 3.5

Design Notes

You have removed 2 inches from the surface of the pavement prior to the overlay in this design.

Resources

PAVEXpress

Non-destructive Testing Method

PA

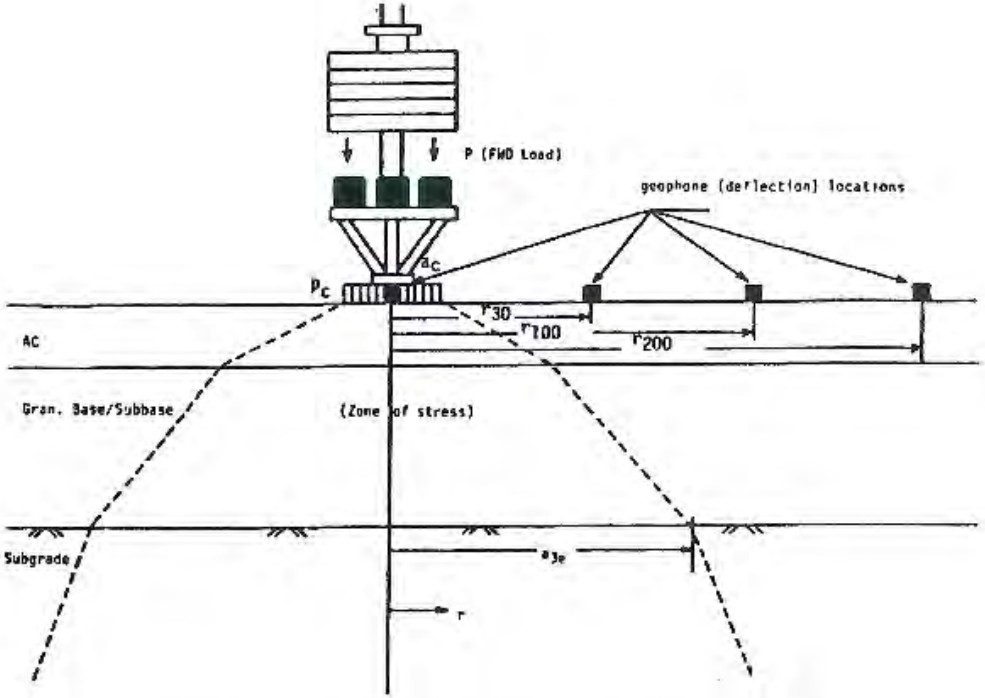

Figure 3.10. Schematic of Stress Zone within Pavement Structure under the FWD Load

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SCENARIO INFORMATION

Scenario Information

Scenario Information

Scenario Name

HWY 32 Mill and HBP overlay

Scenario Description

Non Destructive Testing (FWD) Option

State

North Dakota

Pavement Design

Estimated Completion Year

2019

Roadway Classification

Arterials/Highway

Project Type

AC Overlay on Asphalt

Structural Evaluation Method

NDT

Next

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Web Slice Gallery | Department of Transporta... | Thermal Camera

SCENARIO INFORMATION | PAVEMENT LAYERS | NONDESTRUCTIVE TESTING (NDT) | DESIGN PARAMETERS | TRAFFIC & LOADING | DESIGN GUIDANCE

Pavement Layers

Existing Pavement Layers

Layer Type	Thickness	Action?
Asphalt - Dense Graded	7 in.	
Asphalt stabilized base	3.5 in.	
Aggregate Base	3.5 in.	

Add Layer

Subgrade

Subgrade Soil Type

A-7-6

Subgrade Modulus (M_R)

5000 psi Calculate

New AC Overlay

Layer Coeff. (a)

0.36

Minimum Thickness

0

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SCENARIO INFORMATION | PAVEMENT LAYERS | NONDESTRUCTIVE TESTING (NDT) | DESIGN PARAMETERS | TRAFFIC & LOADING | DESIGN GUIDANCE

Nondestructive Testing (NDT)

Backcalculation Results

Design Subgrade Modulus (M_R)

5000 Calculate

SN_{eff}

3.41 Calculate

Cores

Were cores taken on the roadway?

Yes

Were cores of cracks taken?

Yes

Crack Type

Entire Depth

Delamination/Stripping?

No

Distressed Pavement

Mill/Remove Distressed Asphalt?

Yes

Depth to remove

2 inches

Estimated Structural Coefficient (a_rem)

.32

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Nondestructive Testing (NDT)

Backcalculation Results

Design Subgrade Modulus (M_R)

5000 Calculate

SN_{eff}

3.41 Calculate

Calculate Subgrade Modulus

Applied Load (P) lbs

Radial Distance (r) in

Deflection of radial distance (d_r) in

C-value .33

Subgrade Modulus (M_R) psi

Cancel | Set MR and Close

Distressed Pavement

Mill/Remove Distressed Asphalt? Yes

Depth to remove 2 inches

Estimated Structural Coefficient (a_rem) .32

No

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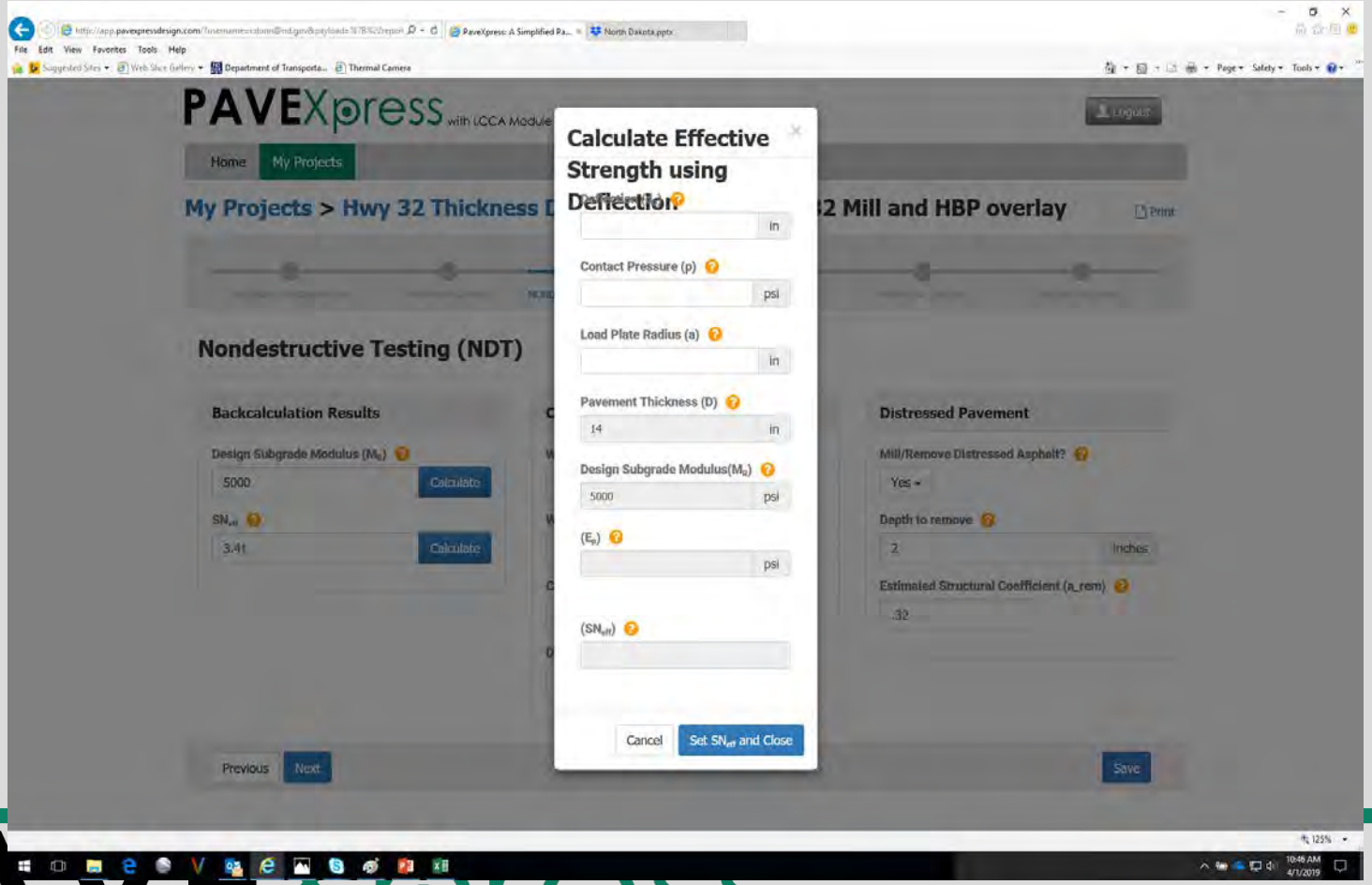
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My Projects > Hwy 32 Thickness D
2 Mill and HBP overlay
Print
Nondestructive Testing (NDT)
Backcalculation Results
Design Subgrade Modulus (M_R)
5000
Calculate
SN_eff
3.41
Calculate
Distressed Pavement
Mill/Remove Distressed Asphalt?
Yes
Depth to remove
2
inches
Estimated Structural Coefficient (a_rem)
.32
Previous
Next
Save
Calculate Effective Strength using Deflection
in
Contact Pressure (p)
psi
Load Plate Radius (a)
in
Pavement Thickness (D)
14
in
Design Subgrade Modulus(M_R)
5000
psi
(E_p)
psi
(SN_eff)
Cancel
Set SN_eff and Close

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DESIGN PARAMETERS

Design Parameters

Design Parameters

Design Period: 20 years

Reliability Level (R): 80 — Z_R = -0.841

Combined Standard Error (S_o): 0.5

Serviceability

Initial Serviceability Index (p_i): 4.5

Terminal Serviceability Index (p_t): 2.5

Change in Serviceability (ΔPSI): 2.00

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TRAFFIC & LOADING

Traffic & Loading

Traffic Data

Method of Determining ESALs

Using AADT | Annual ESALs | Design ESALs

Traffic Growth

Total Design ESALs (W_{18})

1,000,000

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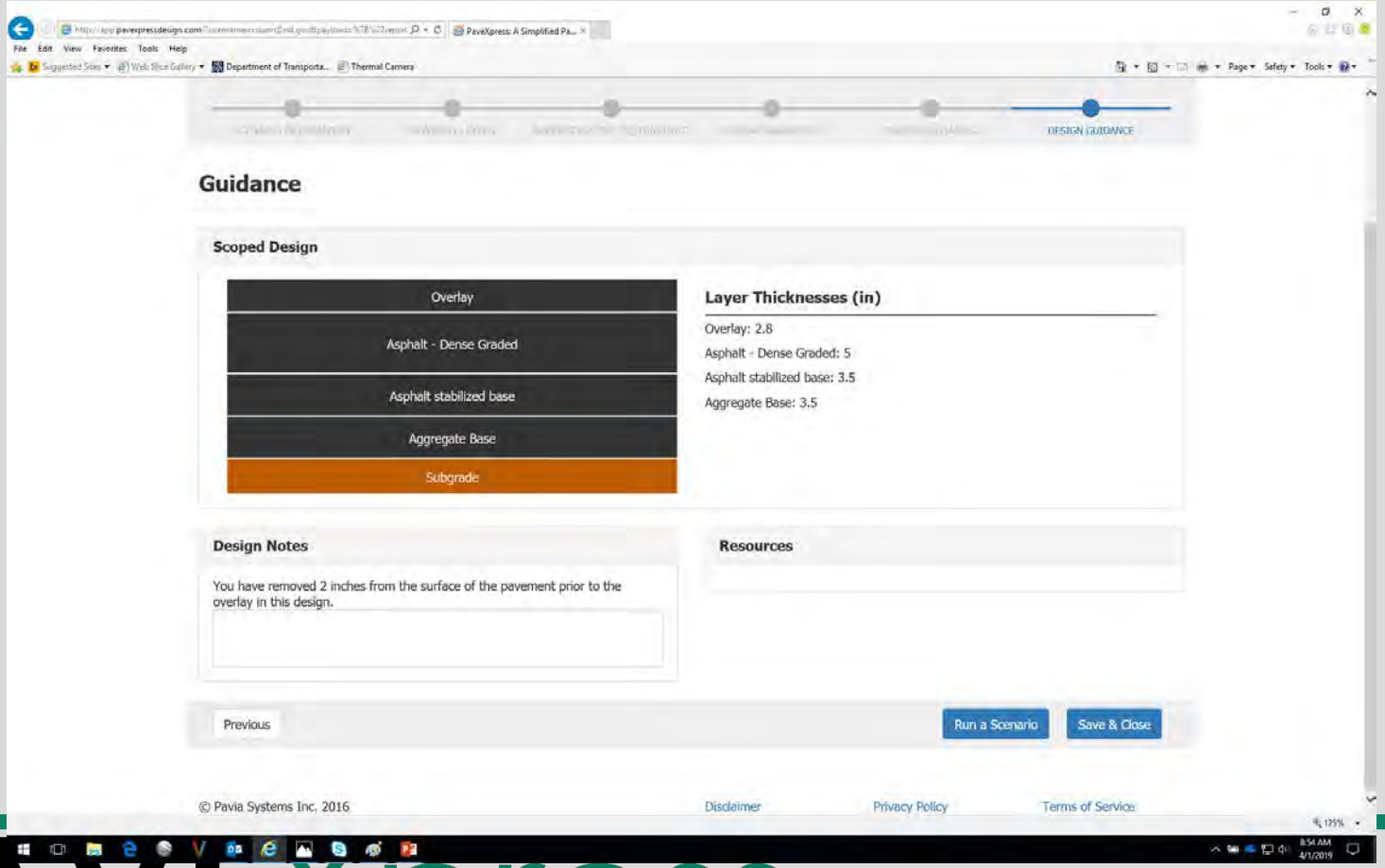
DESIGN GUIDANCE
Guidance
Scoped Design
Overlay
Asphalt - Dense Graded
Asphalt stabilized base
Aggregate Base
Subgrade
Layer Thicknesses (in)
Overlay: 2.8
Asphalt - Dense Graded: 5
Asphalt stabilized base: 3.5
Aggregate Base: 3.5
Design Notes
You have removed 2 inches from the surface of the pavement prior to the overlay in this design.
Resources
Previous
Run a Scenario
Save & Close
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New Design Example

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SCENARIO INFORMATION | DESIGN PARAMETERS | TRAFFIC & LOADING | PAVEMENT STRUCTURE | PAVEMENT SUB-STRUCTURE | DESIGN GUIDANCE

Scenario Information

Scenario Information

Scenario Name

NDakota

Scenario Description

New Project

State

North Dakota

Pavement Design

Estimated Completion Year

2019

Roadway Classification

Arterials/Highway

Project Type

New - Asphalt

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SCENARIO INFORMATION | DESIGN PARAMETERS | TRAFFIC & LOADING | PAVEMENT STRUCTURE | PAVEMENT SUB-STRUCTURE | DESIGN GUIDANCE

Design Parameters

Design Parameters

Design Period: 30 years

Reliability Level (R): 85% — Z_R = -1.036433

Combined Standard Error (S_0): 0.5

Serviceability

Initial Serviceability Index (p_i): 4.5

Terminal Serviceability Index (p_t): 3

Change in Serviceability (ΔPSI): 1.50

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Traffic & Loading

Traffic Data

Method of Determining ESALs

Using AADT | Annual ESALs | Design ESALs

Completion Year Traffic (vehicles)

350000 [Calculate from AADT]

Load Equivalency Factor

0.14 [Calculate LEF]

Completion Year ESALs

49,000

Traffic Growth

Design Period

30 Years

Future Traffic Growth Rate

2 %

ESAL Growth Rate

1 %

Total Design ESALs (W_{18})

2,339,000

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PAVEXpress

Treating Multiple Asphalt Layers Differently

PAVEXpress allows the designer to input for each lift of asphalt a different:

- *layer coefficient*
- *drainage coefficient*
- *thickness*

The designer can either specify individual inputs for the surface, intermediate (binder) course, and base (leaving the program to calculate the base thickness), or input all asphalt info as a single lift and split it into separate lifts afterward.

Optimum Lift Thickness = 4 × NMAS

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SCENARIO INFORMATION | DESIGN PARAMETERS | TRAFFIC & LOADING | PAVEMENT STRUCTURE | PAVEMENT SUB-STRUCTURE | DESIGN GUIDANCE

Pavement Structure

Pavement Structure (Flexible) (Asphalt)

Use Multiple Lifts

No

Layer Coefficient (a)

0.44

Drainage Coefficient (m)

1

Minimum Thickness

2 in

Pavement Diagram

Asphalt Layer

Base Layers

Subgrade

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PAVEXpress

Layer Coefficient Considerations

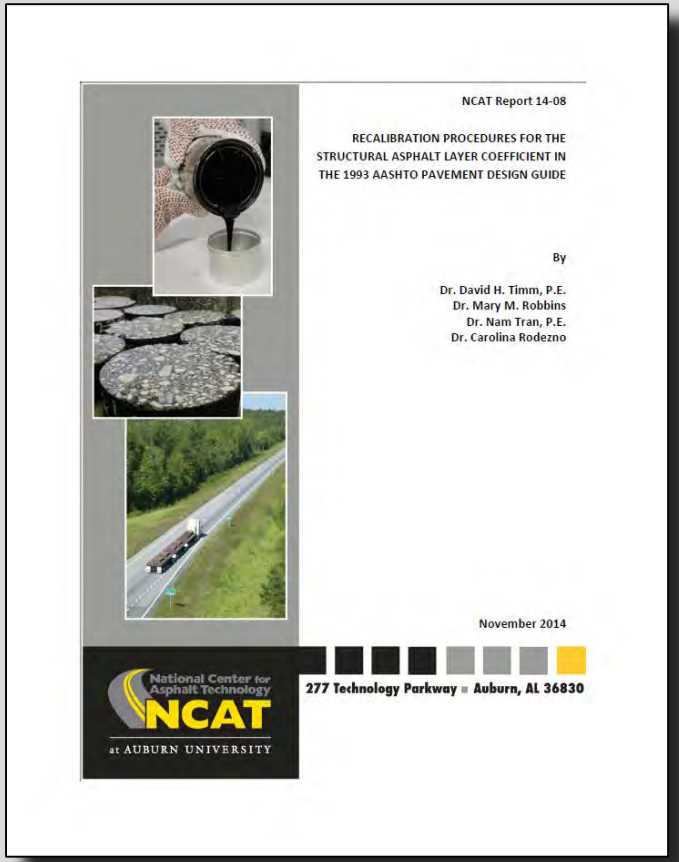
Average values of layer coefficients for materials used in the AASHO Road Test were as follows:

Asphalt Surface Course	0.44
Crushed Stone Base Course	0.14
Sandy Gravel Subbase	0.11

Keep in mind that these values were empirically derived from a road test with one climate, one soil type, and one asphalt mix type.

The asphalt layer coefficient used for the Road Test was actually a weighted average of values ranging from 0.33 to 0.83.

More recent studies at the NCAT Test Track found that for Alabama, an asphalt layer coefficient of 0.54 better reflected actual performance.



NCAT Report 14-08

RECALIBRATION PROCEDURES FOR THE STRUCTURAL ASPHALT LAYER COEFFICIENT IN THE 1993 AASHTO PAVEMENT DESIGN GUIDE

By

Dr. David H. Timm, P.E.
Dr. Mary M. Robbins
Dr. Nam Tran, P.E.
Dr. Carolina Rodezno

November 2014

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

277 Technology Parkway ■ Auburn, AL 36830

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SCENARIO INFORMATION | DESIGN PARAMETERS | TRAFFIC & LOADING | PAVEMENT STRUCTURE | PAVEMENT SUB-STRUCTURE | DESIGN GUIDANCE

Pavement Sub-Structure

Base Layers

Layer Type	Layer Coef.	Drainage Coef.	Thickness	Resilient Mod	Action?
Aggregate Base	0.12	1	6 in.	28000	
Aggregate Subbase	0.065	1	2 in.	21000	

Add Layer

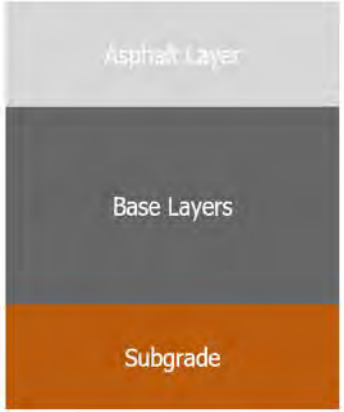
Subgrade

Resilient Modulus (M_R)

15000 psi

Calculate MR

Pavement Diagram



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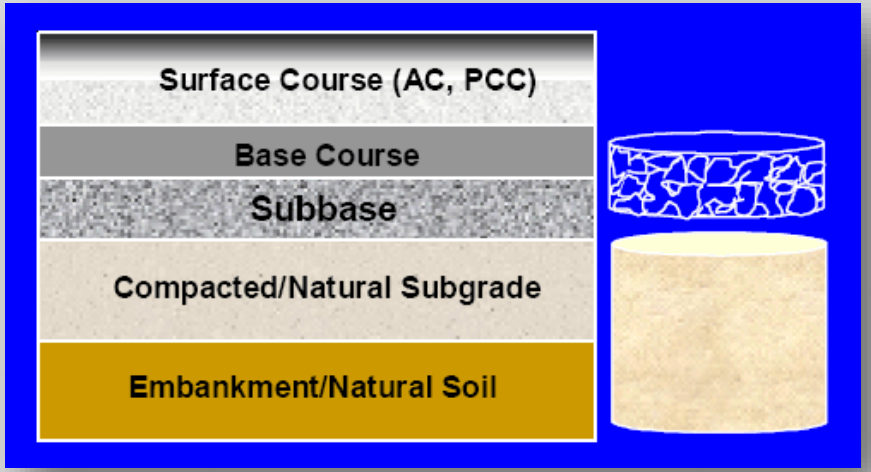
Subgrade Considerations

The most common methods of classifying the subgrade for pavement design are:

- California Bearing Ratio (CBR)
- Resistance Value (R)
- Resilient Modulus (M_R)



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SCENARIO INFORMATION | DESIGN PARAMETERS | TRAFFIC & LOADING | PAVEMENT STRUCTURE | PAVEMENT SUB-STRUCTURE | DESIGN GUIDANCE

Guidance

Scoped Design

Required minimum design SN: 3.15

Layer Thicknesses (in)

Surface: 6.00

Aggregate Base: 6.00

Aggregate Subbase: 2.00

Total SN: 3.49

⚠ The Design SN exceeds the Required SN due to the layer protection check. A base layer thickness can be reduced; however, the reduction may create issues with construction. Therefore, care must be taken before adjusting the fixed or minimum thickness.

Design Notes

Resources

HTML

Dakota Asphalt Pavement Association

PAVEXpress

Calculated Design

Recommendation:

Perform multiple iterations of the design with different plausible input values to get a sense of the range of pavement structures needed to carry the anticipated loads in various scenarios.

Use engineering judgment to select the optimum pavement structure.

Additional PAVEXpress Functions

Life Cycle Cost Analysis

Layered Elastic Analysis

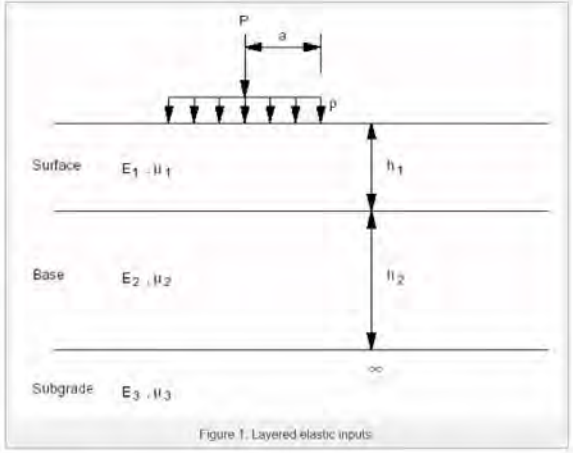


Figure 1. Layered elastic inputs

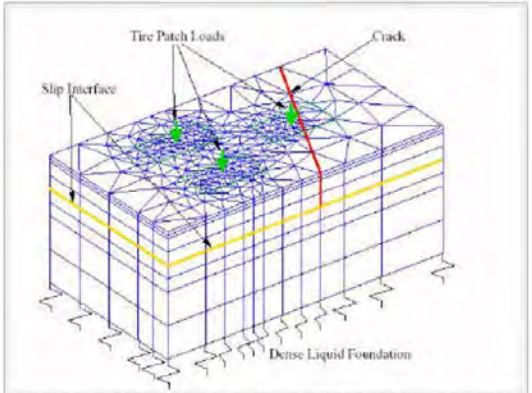


Figure 3. EverFlex 3-D drawing (adapted from Wu, 2001). The drawing shows the discrete elements, wheel loads (tire patch loads), a modeled crack and a slip interface (where on layer can slip - move independently - from another).

Parking Lot Design Guidance

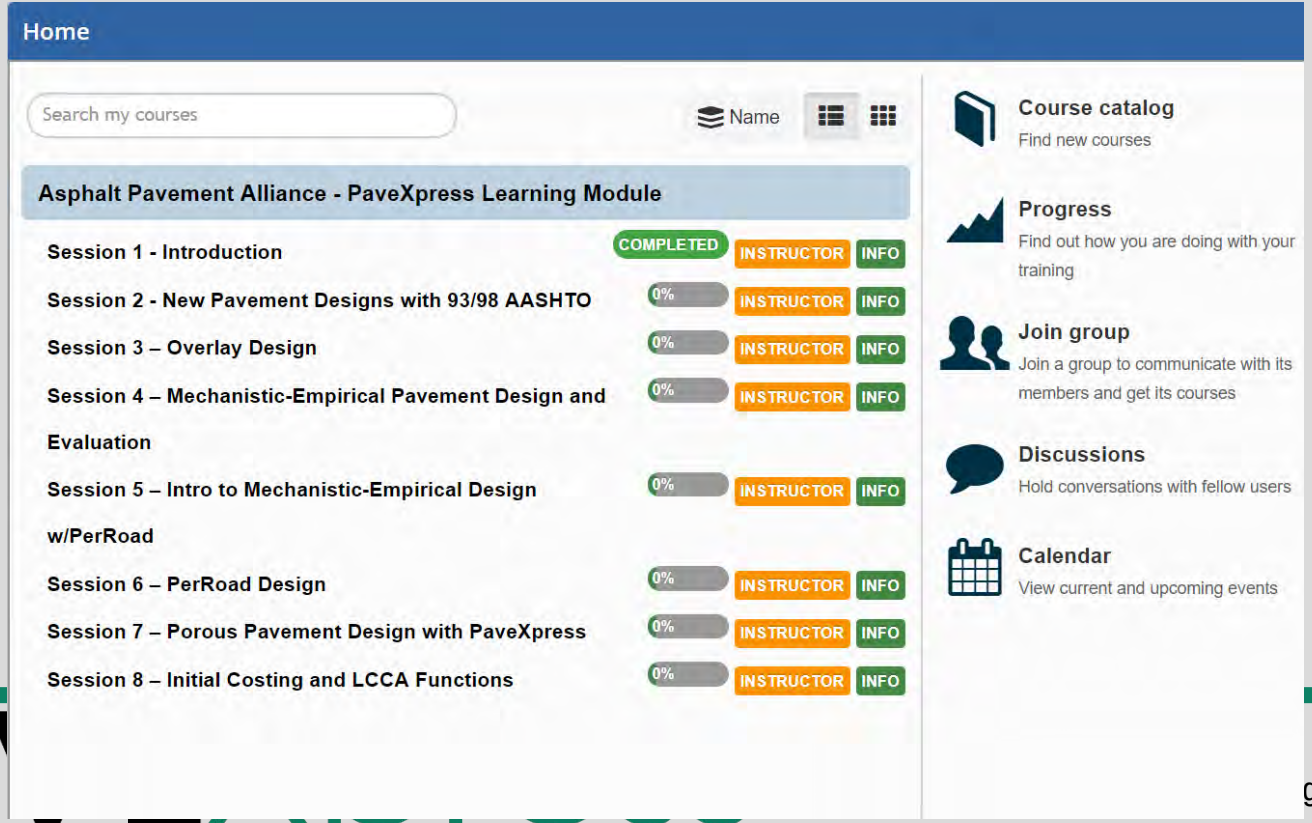
Porous Pavement Design

PAVEInstruct.com Learning Module

complement to PAVEXpress

- Available on-demand via web
- Flexible and rigid pavement design
- Detailed use of PAVEXpress
- Leading industry expert instructors
- No cost to user
- PDHs available

Pavement Design Learning Modules PAVEInstruct.com



Mark as completed and continue

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PAVEInstruct

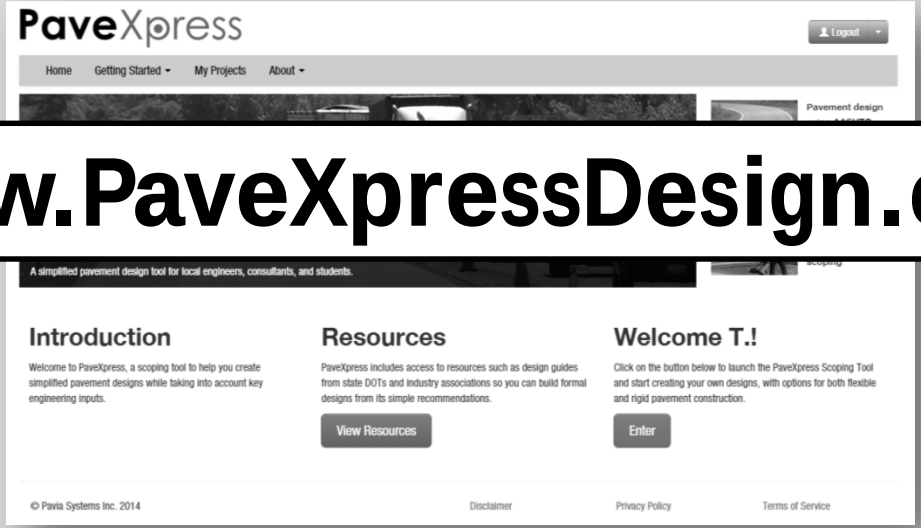
So What Is Coming Next?

Next Version Features

- ME Design with PerRoad Embedded
- Simplified LCCA
- Metric Units

PaveXpress

A Simplified Pavement Design Tool



www.PaveXpressDesign.com

Thank you!

women of asphalt

WOMEN OF ASPHALT

WE LEAD AND INSPIRE WOMEN IN THE ASPHALT INDUSTRY

- Women of Asphalt is a national coalition which supports women in all aspects of the asphalt industry through mentoring, education, and advocacy, and by encouraging women to seek careers in the asphalt industry.

(904) 446-0758 ● 2233 Park Ave, Ste 200U ● Orange Park, FL 32073 ● info@womenofasphalt.org