# Pavement Design for Practitioners - PAVEXpress


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ND DOT

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Asphalt Pavement Alliance

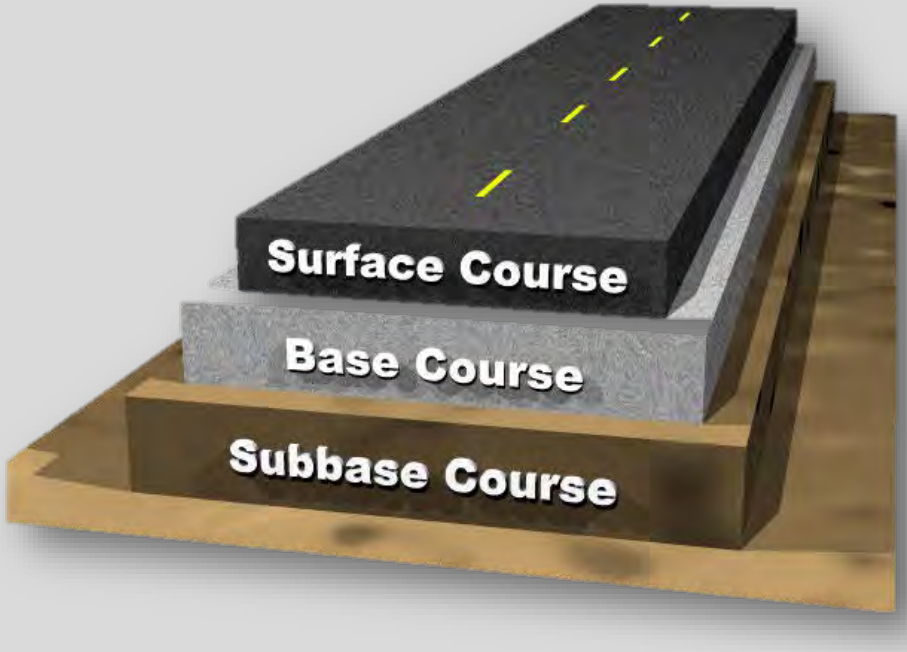

APA ASPHALT PAVEMENT ALLIANCE

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

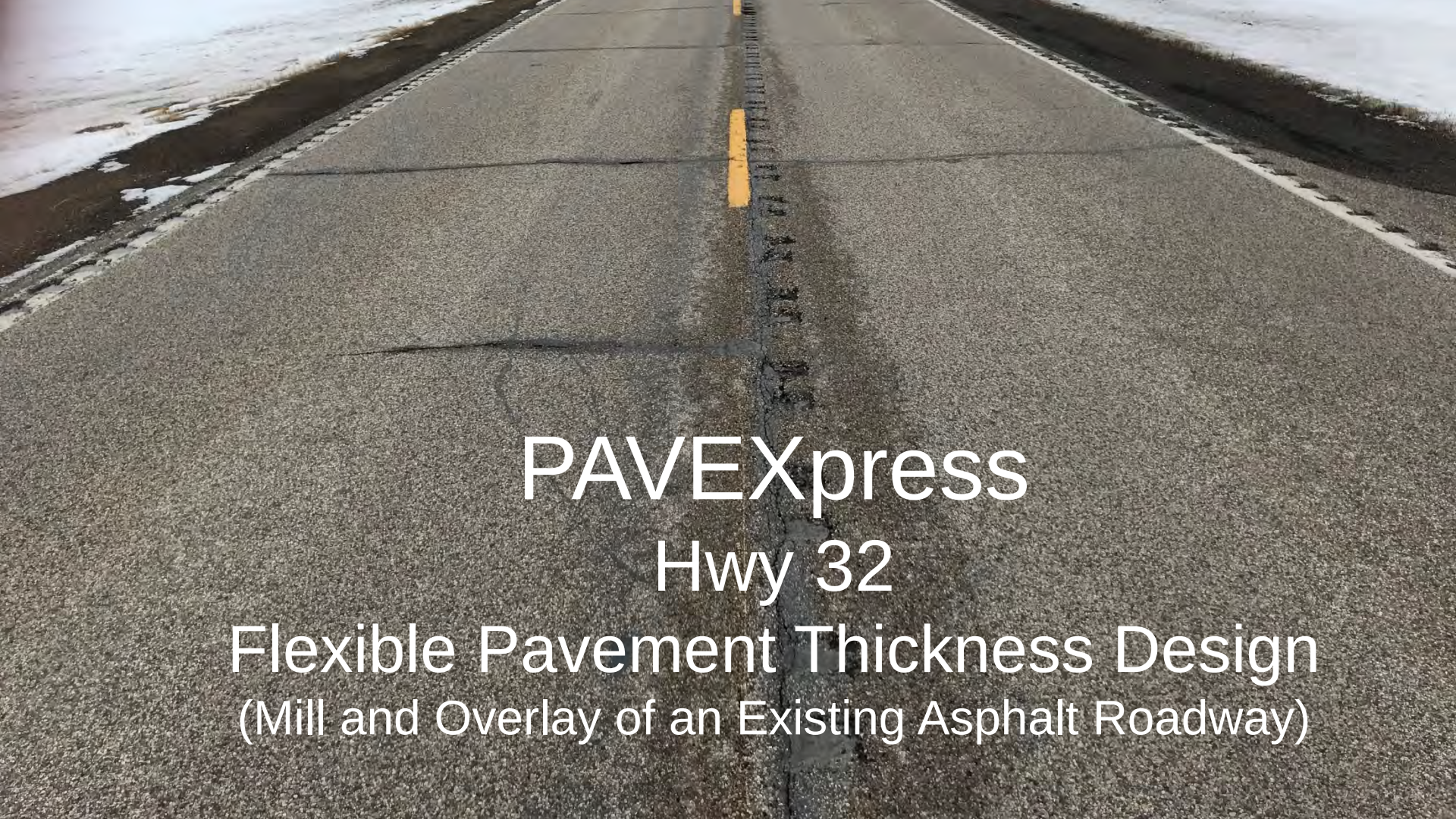
# PAVEXpress Examples

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)

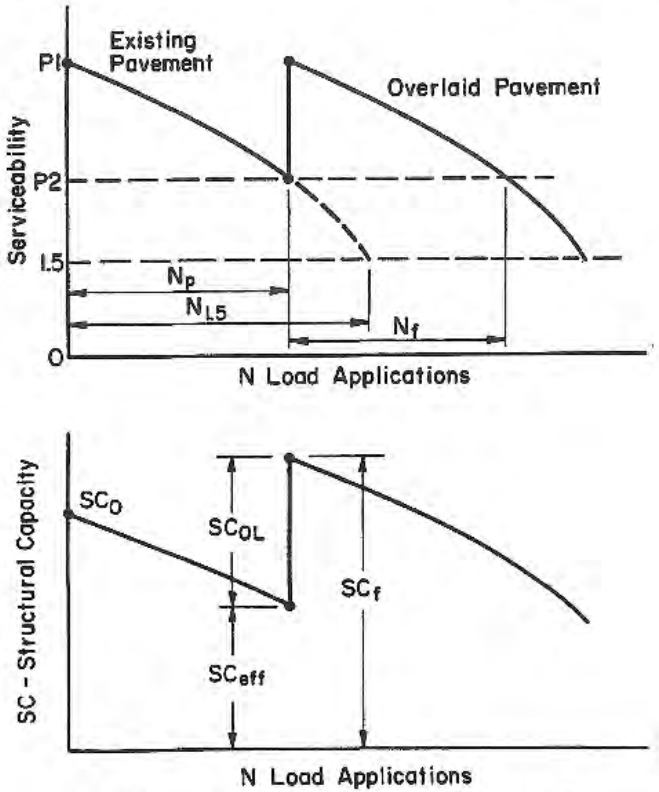



Figure 5.1. Illustration of Structural Capacity Loss Over Time and with Traffic

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

PAV

# Pavement Coring


PAV

# Overlay Design Inputs

Reliability 80%

Initial Serviceability 4.5

Terminal Serviceability 2.5

Design ESAL's 1,000,000

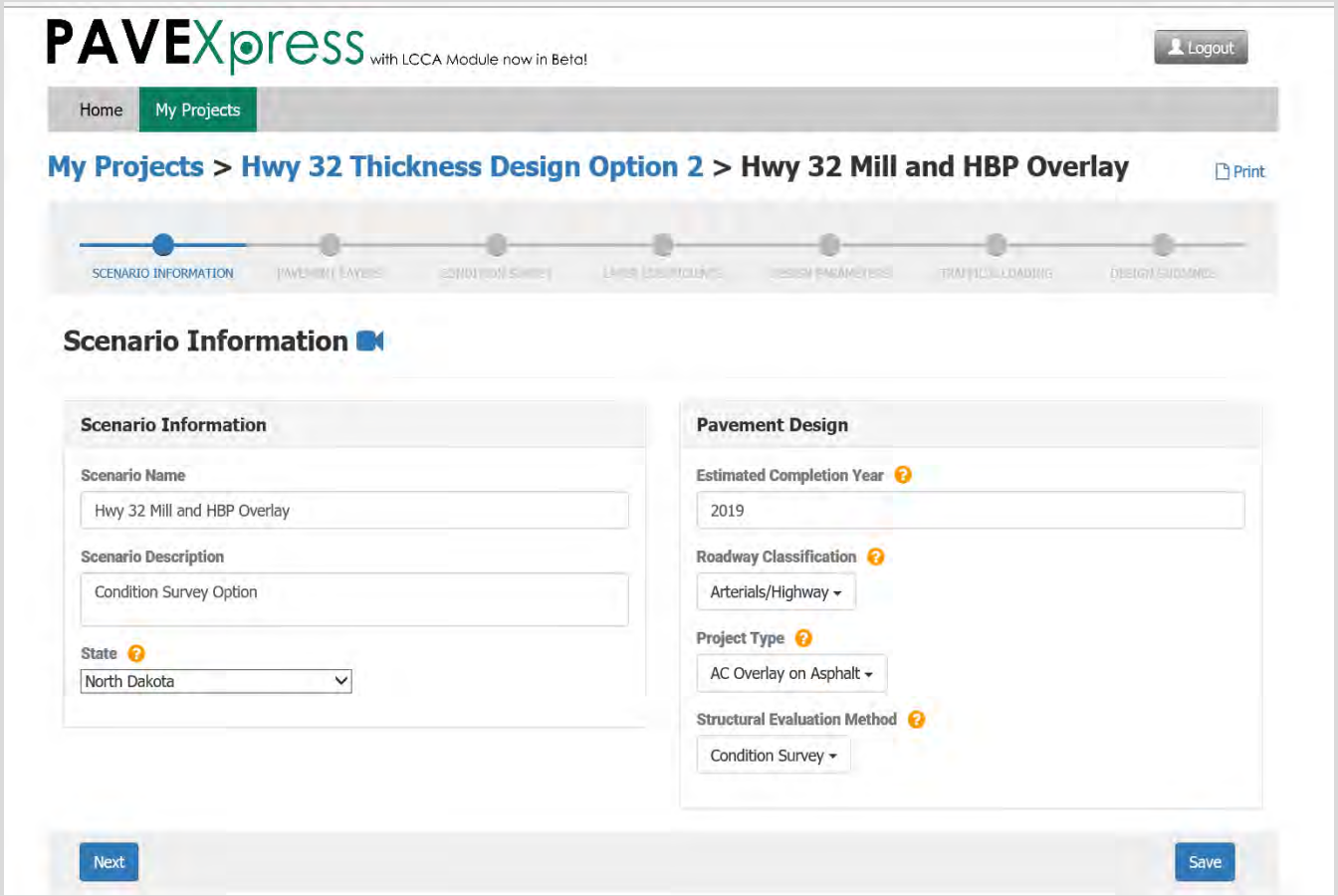
Analysis Period 20 years

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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Home
My Projects
My Projects > Hwy 32 Thickness Design Option 2 > Hwy 32 Mill and HBP Overlay
Print
SCENARIO INFORMATION
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
Save

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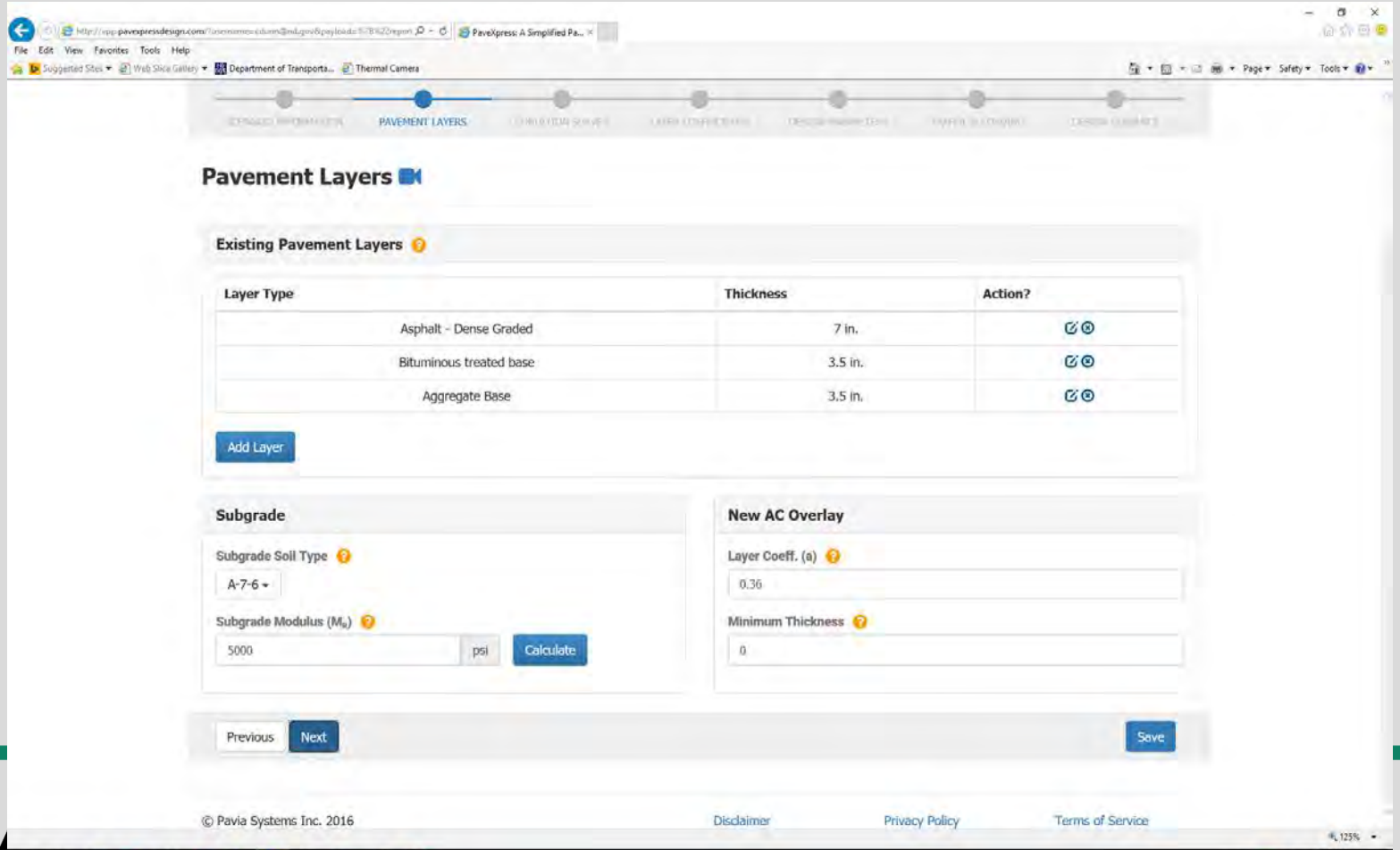
PAVEMENT LAYERS
Pavement Layers
Existing Pavement Layers
Layer Type
Thickness
Action?
Asphalt - Dense Graded
7 in.
Bituminous treated base
3.5 in.
Aggregate Base
3.5 in.
Add Layer
Subgrade
Subgrade Soil Type
A-7-6
Subgrade Modulus (Mr)
5000
psi
Calculate
New AC Overlay
Layer Coeff. (a)
0.36
Minimum Thickness
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

Previous Next Save





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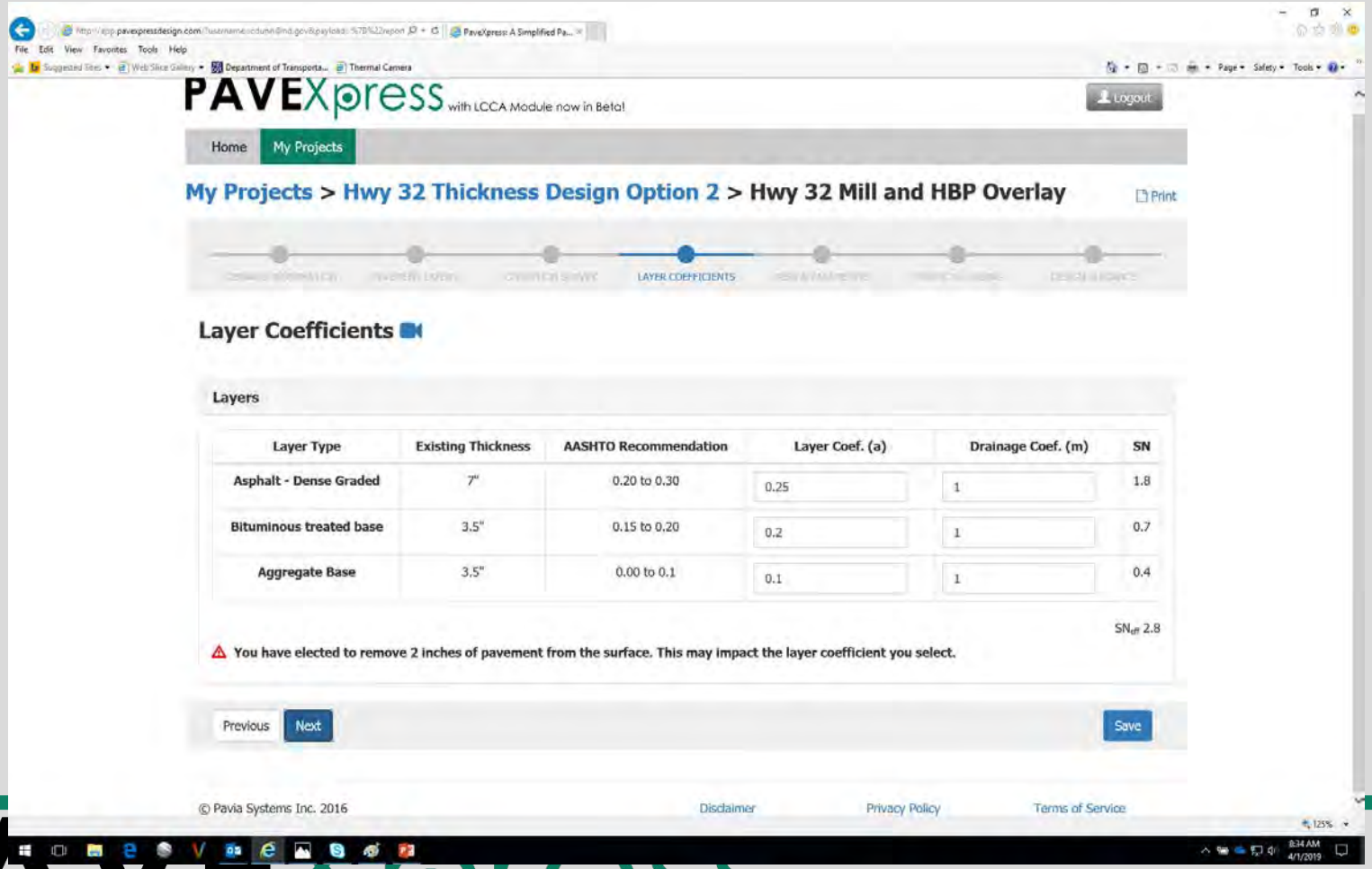
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Print
LAYER COEFFICIENTS
Layer Coefficients
Layers
Layer Type
Existing Thickness
AASHTO Recommendation
Layer Coef. (a)
Drainage Coef. (m)
SN
Asphalt - Dense Graded
7"
0.20 to 0.30
0.25
1
1.8
Bituminous treated base
3.5"
0.15 to 0.20
0.2
1
0.7
Aggregate Base
3.5"
0.00 to 0.1
0.1
1
0.4
SNeff 2.8
You have elected to remove 2 inches of pavement from the surface. This may impact the layer coefficient you select.
Previous
Next
Save
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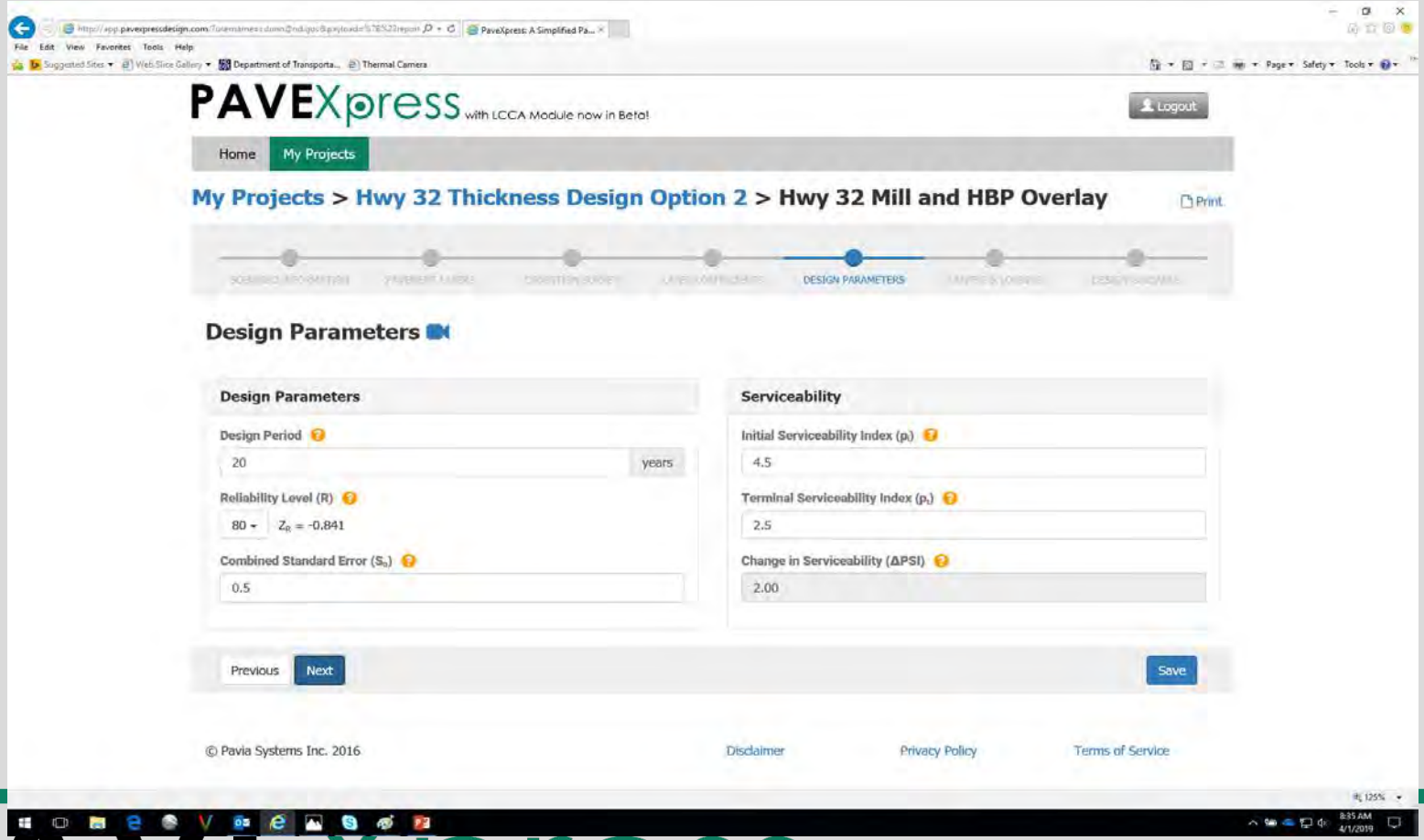
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Print
DESIGN PARAMETERS
Design Parameters
Design Parameters
Design Period
20
years
Reliability Level (R)
80
$Z_R$ = -0.841
Combined Standard Error ($S_o$)
0.5
Serviceability
Initial Serviceability Index ($p_i$)
4.5
Terminal Serviceability Index ($p_t$)
2.5
Change in Serviceability (ΔPSI)
2.00
Previous
Next
Save
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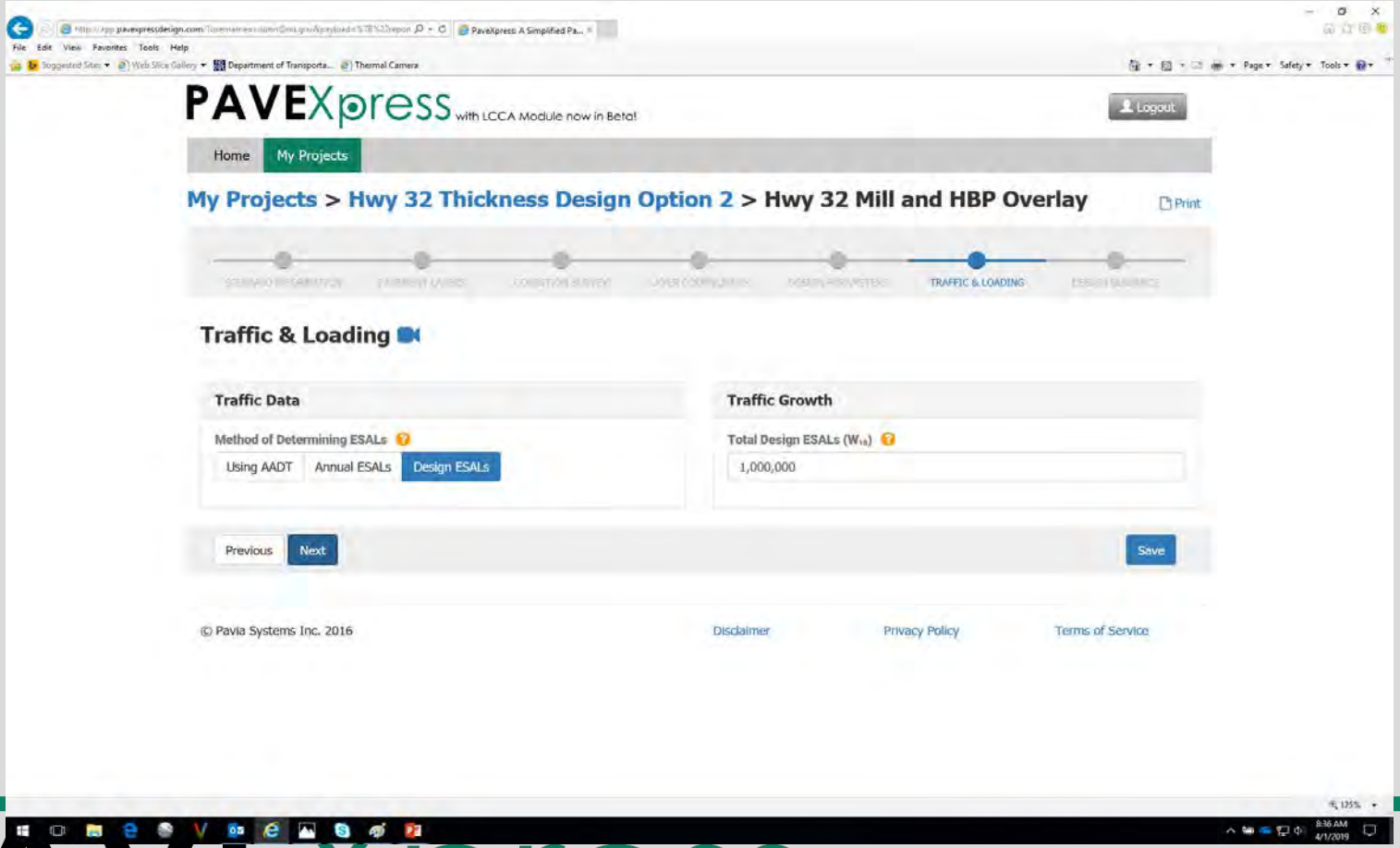
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Print
TRAFFIC & LOADING
Traffic & Loading
Traffic Data
Method of Determining ESALs
Using AADT
Annual ESALs
Design ESALs
Traffic Growth
Total Design ESALs (W18)
1,000,000
Previous
Next
Save
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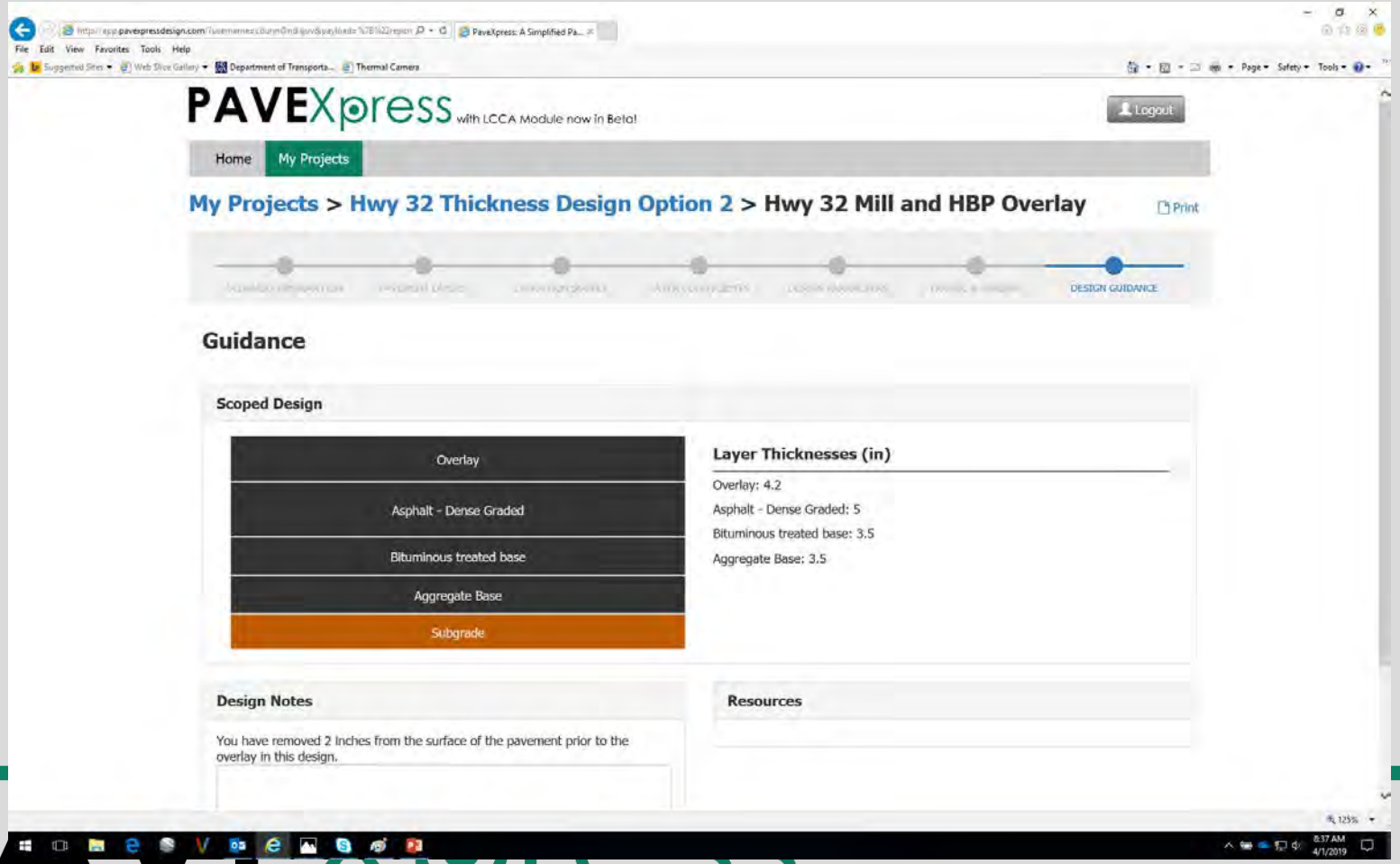
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My Projects > Hwy 32 Thickness Design Option 2 > Hwy 32 Mill and HBP Overlay
Print
DESIGN GUIDANCE
Guidance
Scoped Design
Overlay
Asphalt - Dense Graded
Bituminous treated base
Aggregate Base
Subgrade
Layer Thicknesses (in)
Overlay: 4.2
Asphalt - Dense 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

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# Non-destructive Testing Method

PA

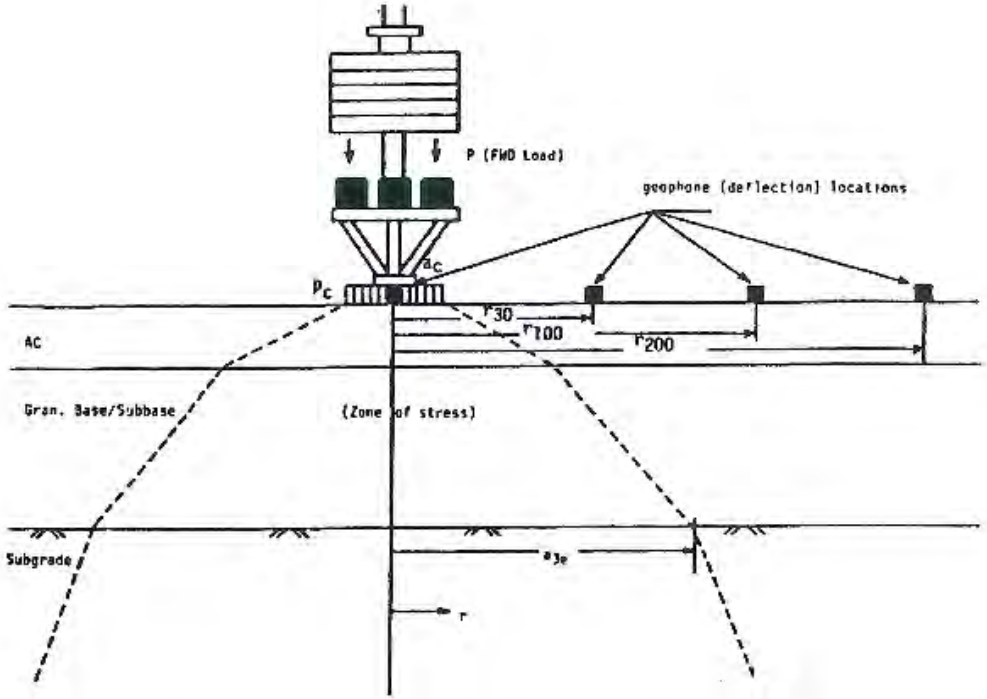
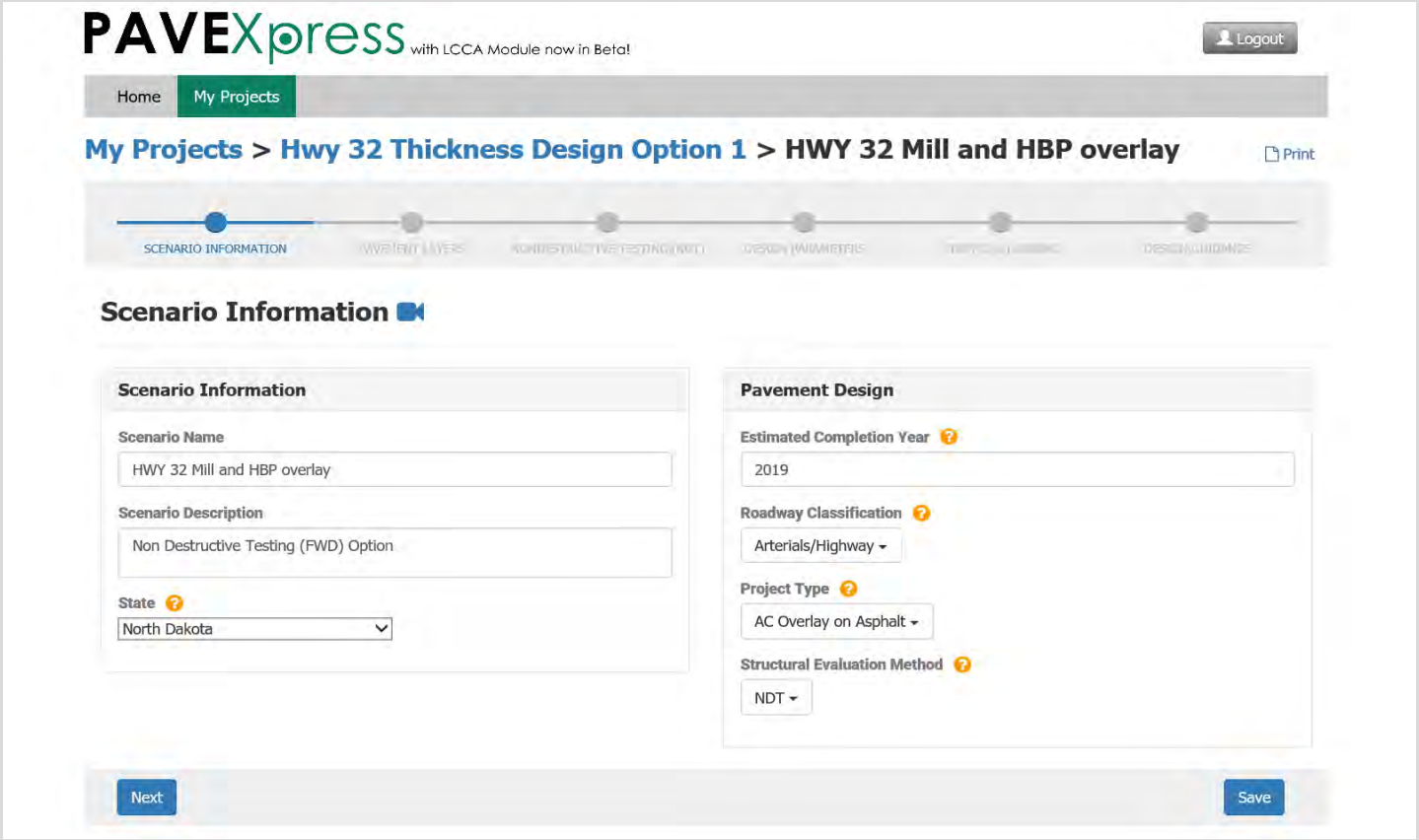



Figure 3.10. Schematic of Stress Zone within Pavement Structure under the FWD Load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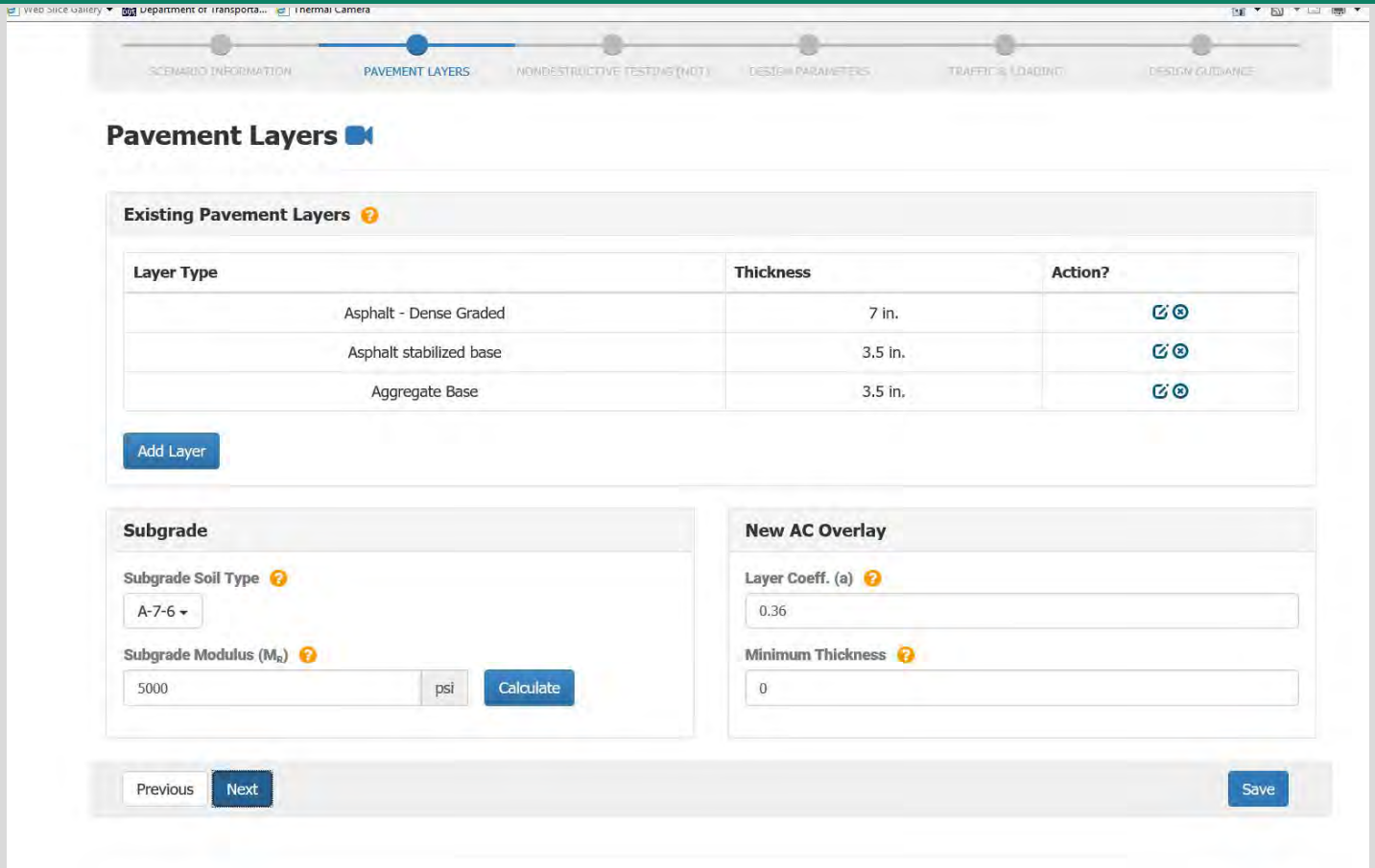
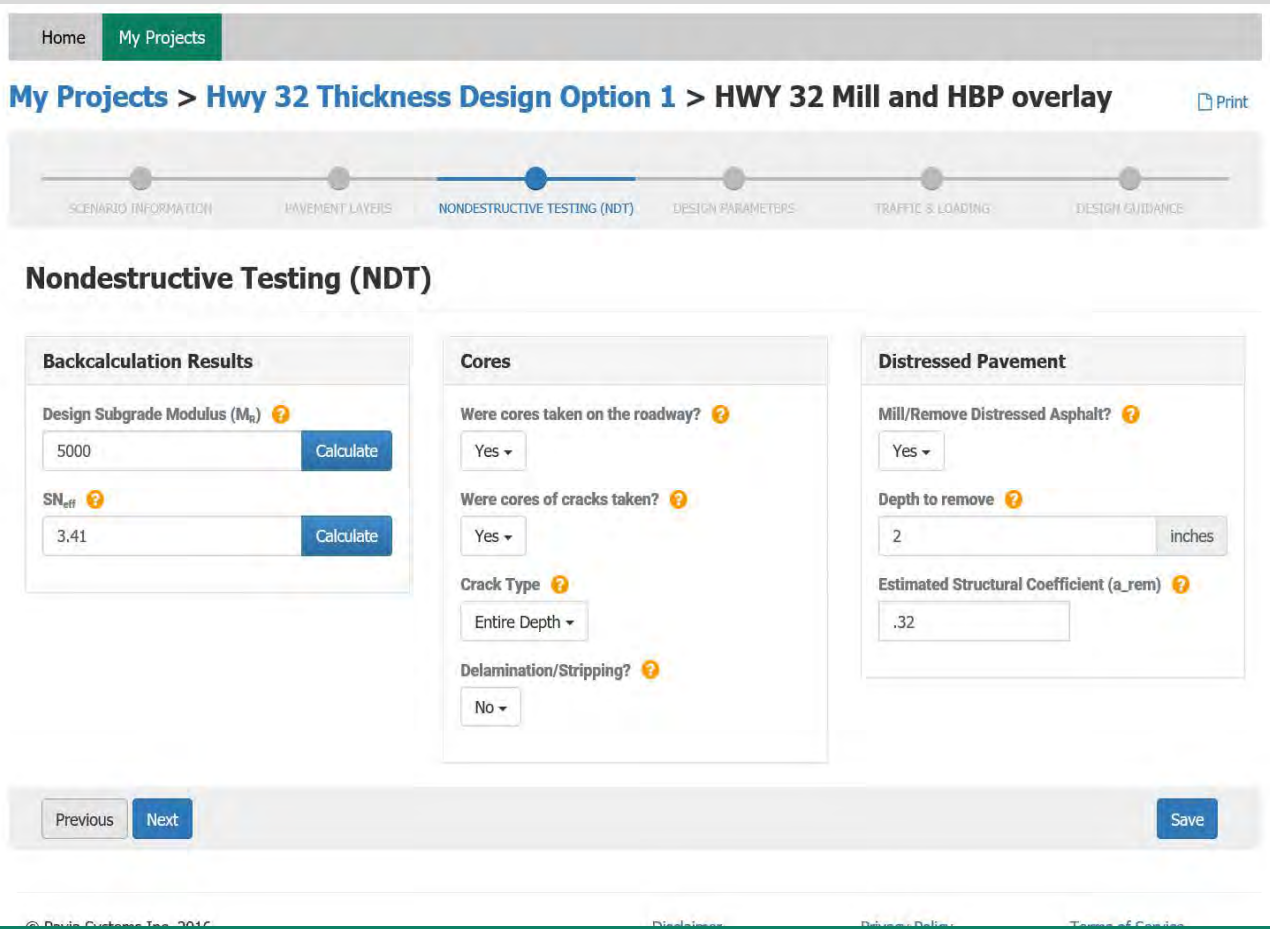
Logout
Home
My Projects
My Projects > Hwy 32 Thickness Design Option 1 > HWY 32 Mill and HBP overlay
Print
SCENARIO INFORMATION
Scenario Information
Scenario Information
Scenario Name
HWY 32 Mill and HBP overlay
Scenario Description
Non Destructive Testing (FWD) Option
State
North Dakota
Pavement Design
Estimated Completion Year
2019
Roadway Classification
Arterials/Highway
Project Type
AC Overlay on Asphalt
Structural Evaluation Method
NDT
Next
Save

PAVEXpress


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
Previous
Next
Save

PAVEXpress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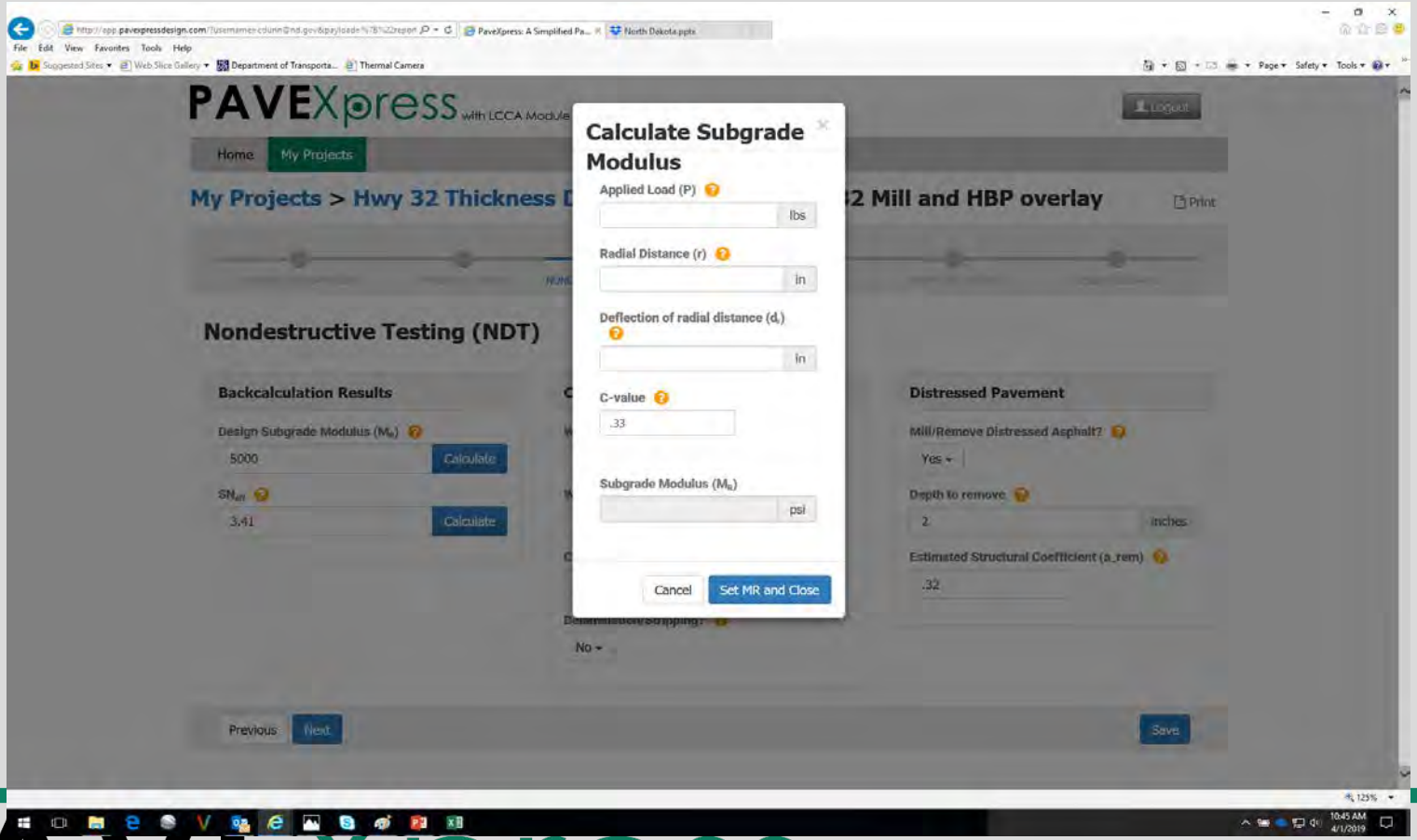
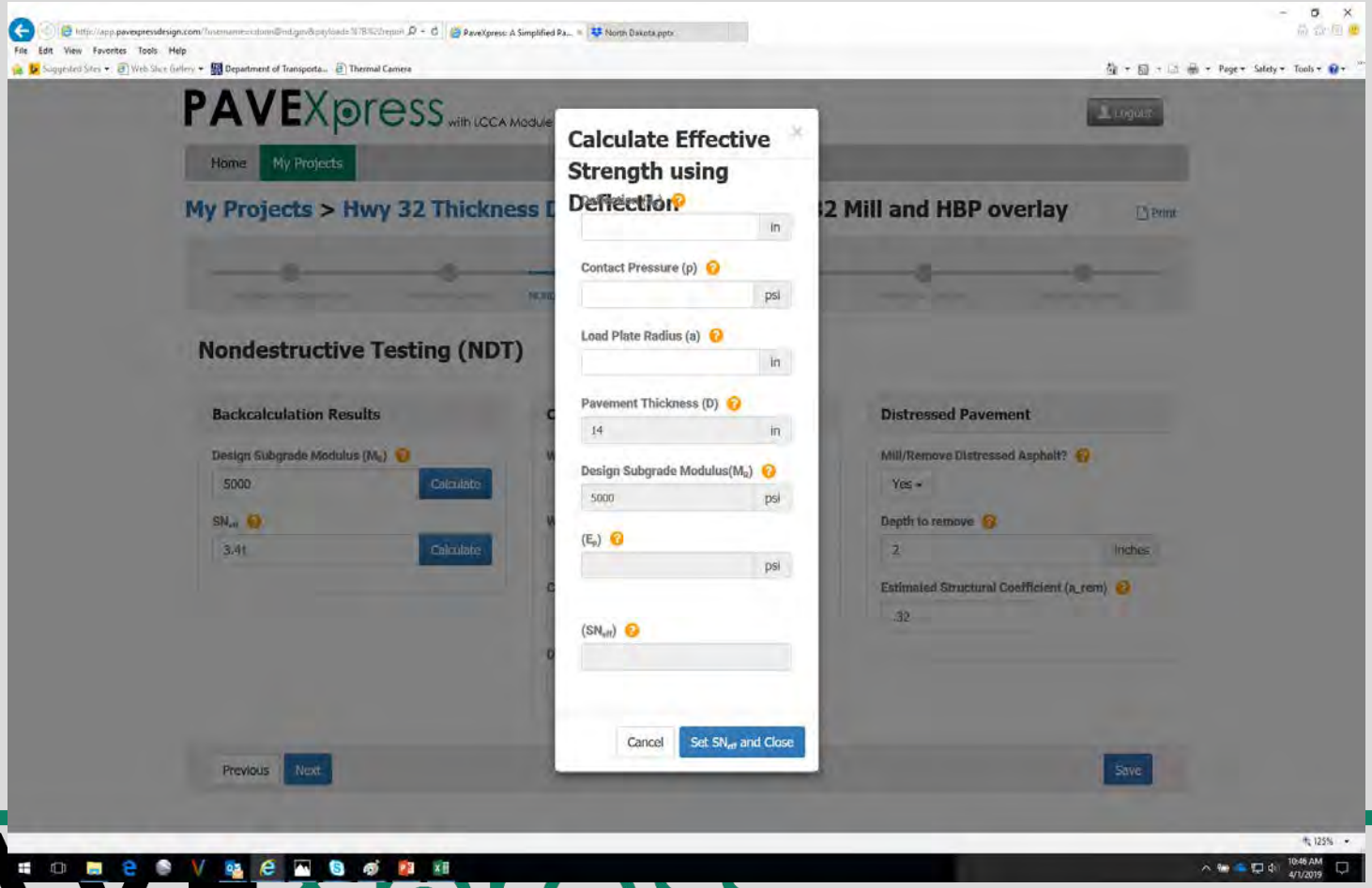
My Projects > Hwy 32 Thickness Design Option 1 > HWY 32 Mill and HBP overlay
Print
SCENARIO INFORMATION
PAVEMENT LAYERS
NONDESTRUCTIVE TESTING (NDT)
DESIGN PARAMETERS
TRAFFIC & LOADING
DESIGN GUIDANCE
Nondestructive Testing (NDT)
Backcalculation Results
Design Subgrade Modulus ($M_R$)
5000
Calculate
$SN_{eff}$
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
Previous
Next
Save

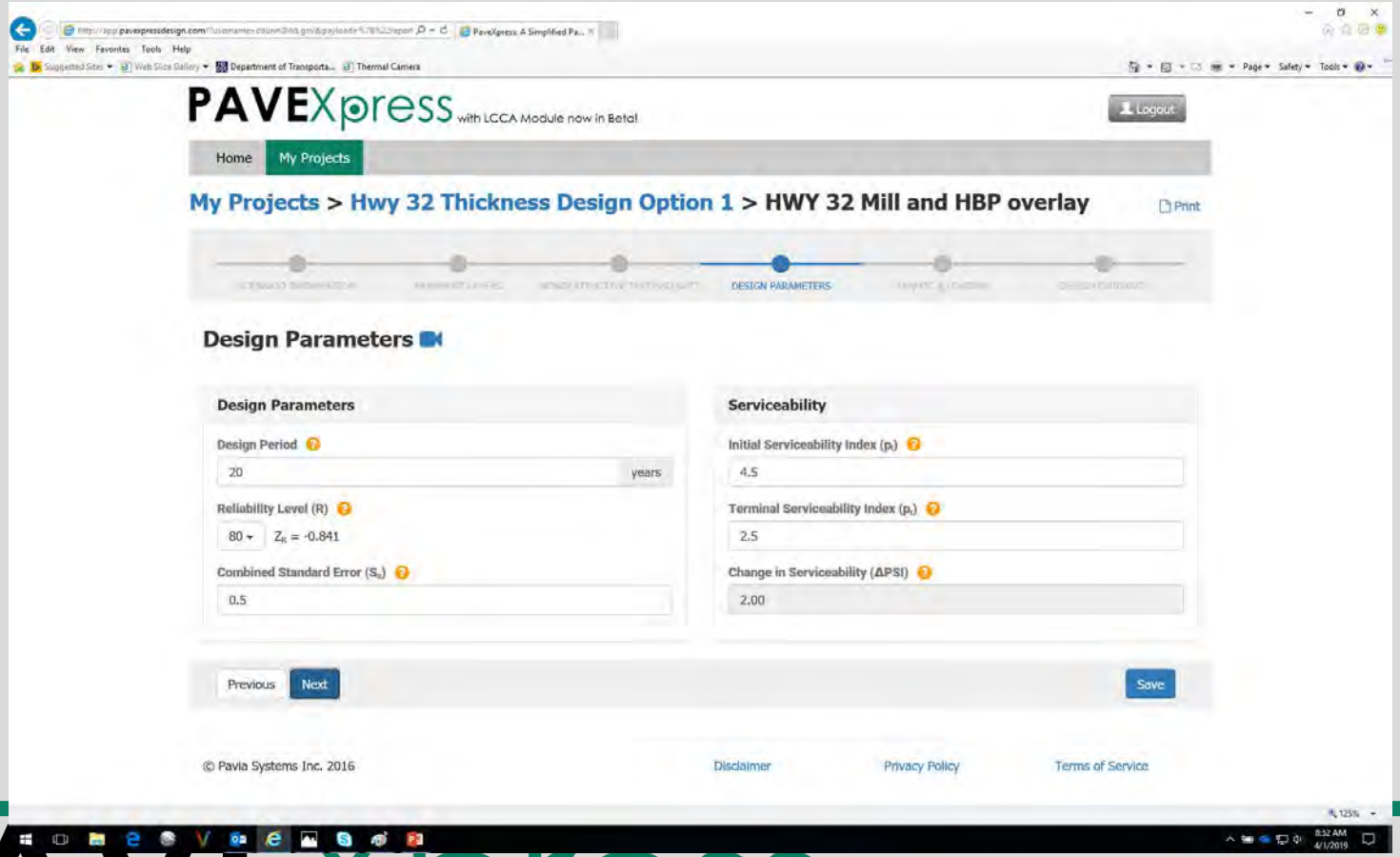
PAVEXpress


PAVEXpress with LCCA Module
Logout
Home
My Projects
My Projects > Hwy 32 Thickness D
2 Mill and HBP overlay
Print
Nondestructive Testing (NDT)
Backcalculation Results
Design Subgrade Modulus (Mr)
5000
Calculate
SNeff
3.41
Calculate
Distressed Pavement
Mill/Remove Distressed Asphalt?
Yes
Depth to remove
2
inches
Estimated Structural Coefficient (a_rem)
.32
No
Previous
Next
Save
Calculate Subgrade Modulus
Applied Load (P)
lbs
Radial Distance (r)
in
Deflection of radial distance (dr)
in
C-value
.33
Subgrade Modulus (Mr)
psi
Cancel
Set MR and Close

PAVEXpress


PAVEXpress with LCCA Module
Logout
Home
My Projects
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

PAVEXpress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Home
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My Projects > Hwy 32 Thickness Design Option 1 > HWY 32 Mill and HBP overlay
Print
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
Previous
Next
Save
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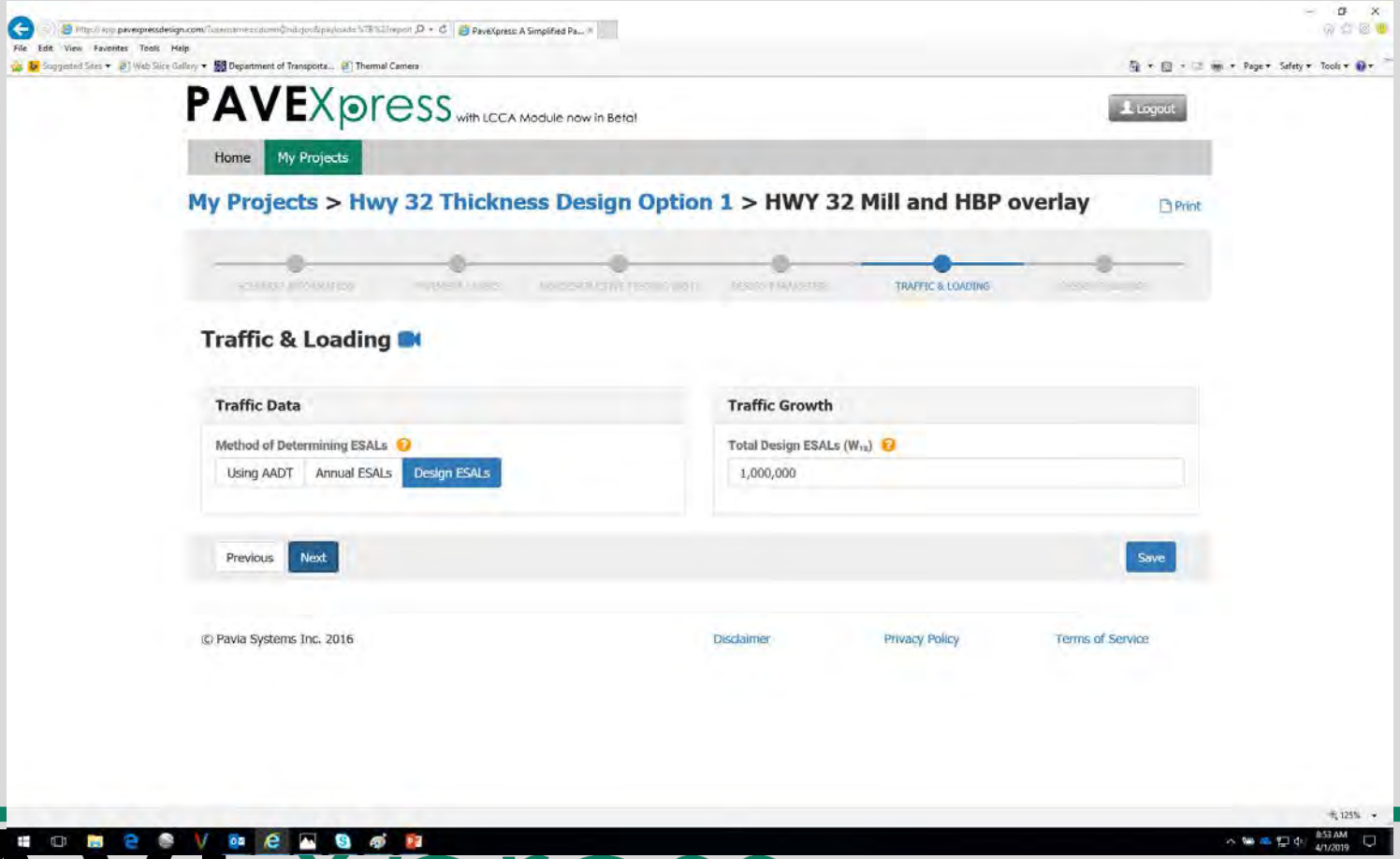
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Print
TRAFFIC & LOADING
Traffic & Loading
Traffic Data
Method of Determining ESALs
Using AADT
Annual ESALs
Design ESALs
Traffic Growth
Total Design ESALs (W18)
1,000,000
Previous
Next
Save
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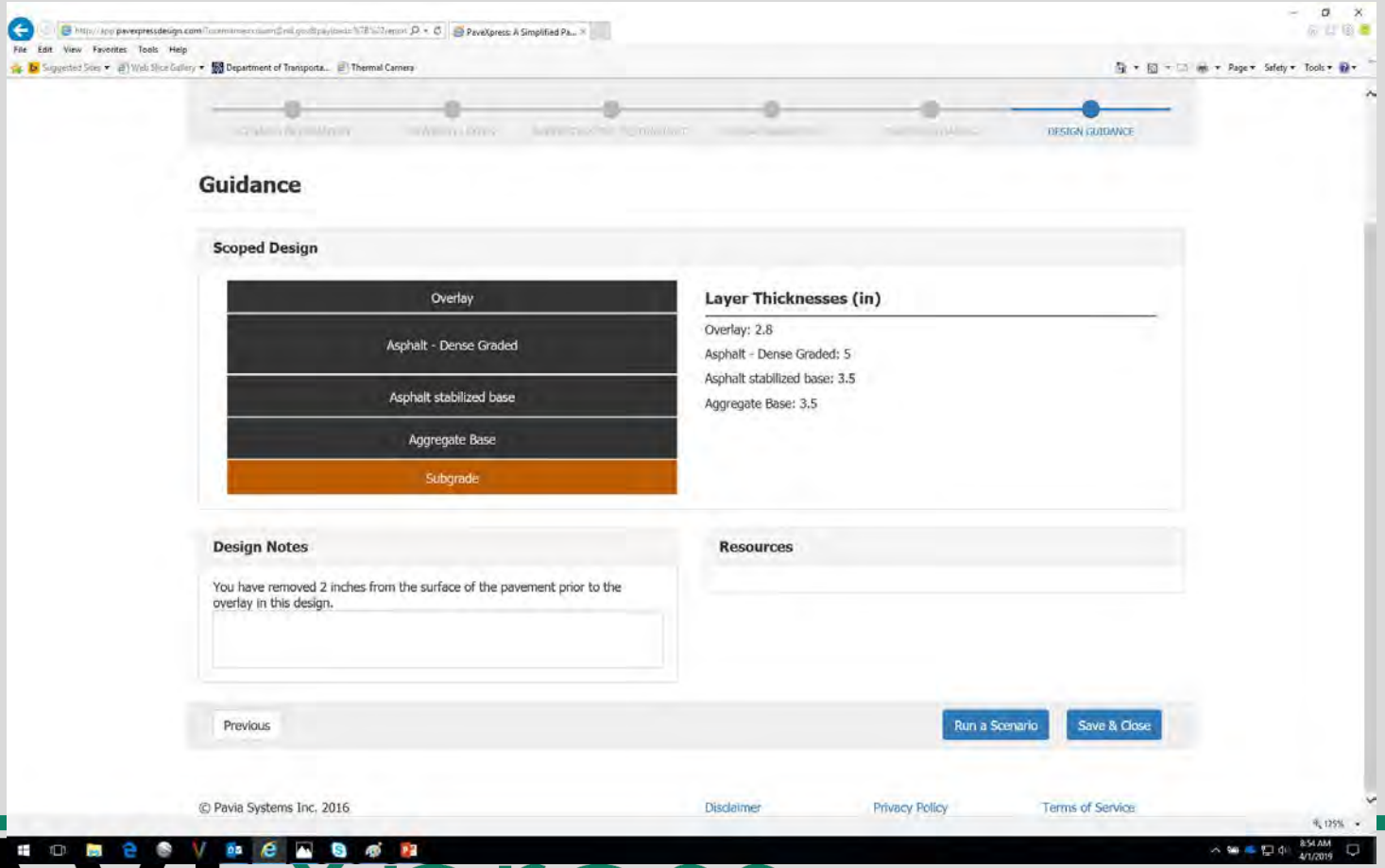
PaveXpress: A Simplified Pa...
File Edit View Favorites Tools Help
Department of Transporta...
Thermal Camera
DESIGN GUIDANCE
Guidance
Scoped Design
Overlay
Asphalt - Dense Graded
Asphalt stabilized base
Aggregate Base
Subgrade
Layer Thicknesses (in)
Overlay: 2.8
Asphalt - Dense Graded: 5
Asphalt stabilized 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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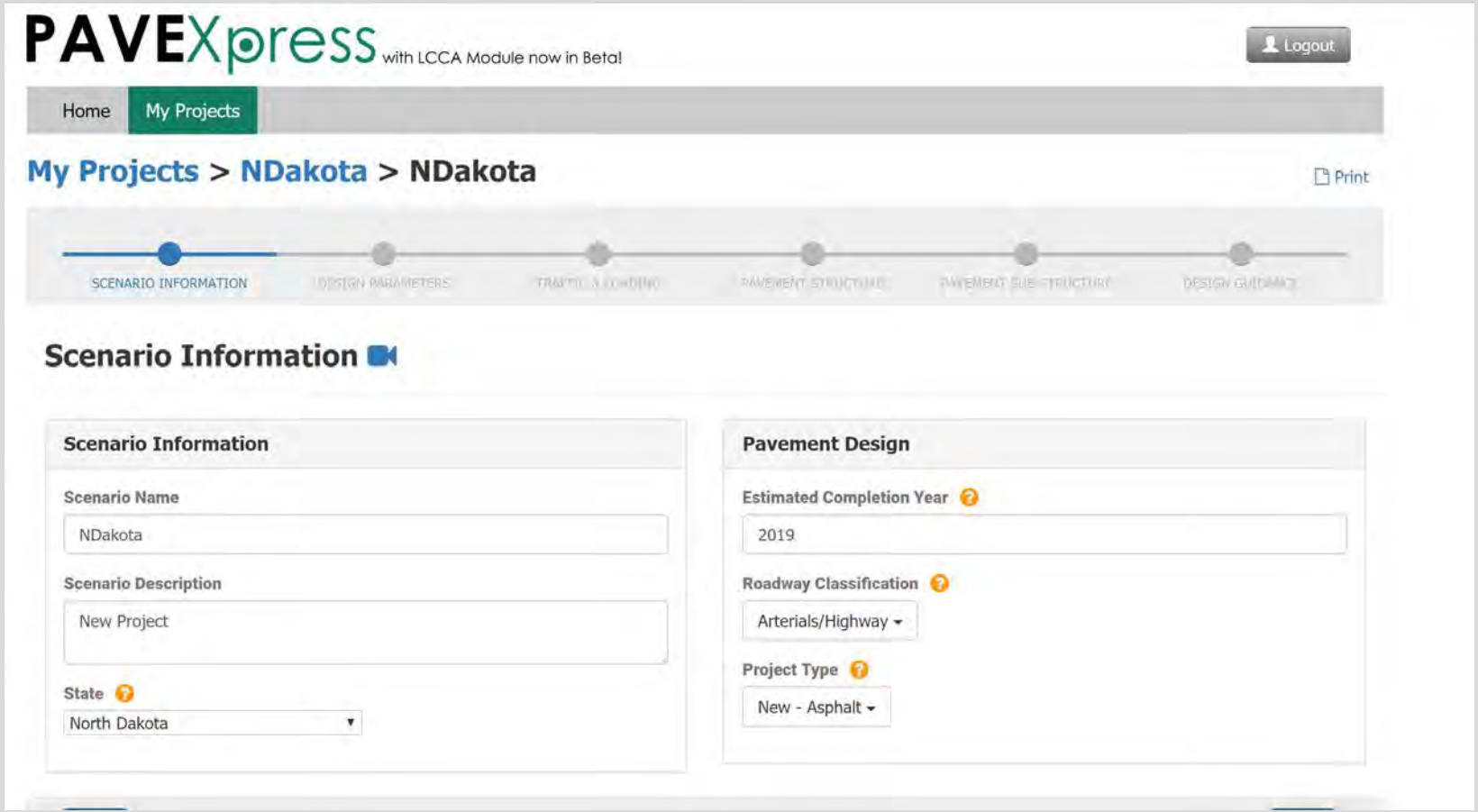
# New Design Example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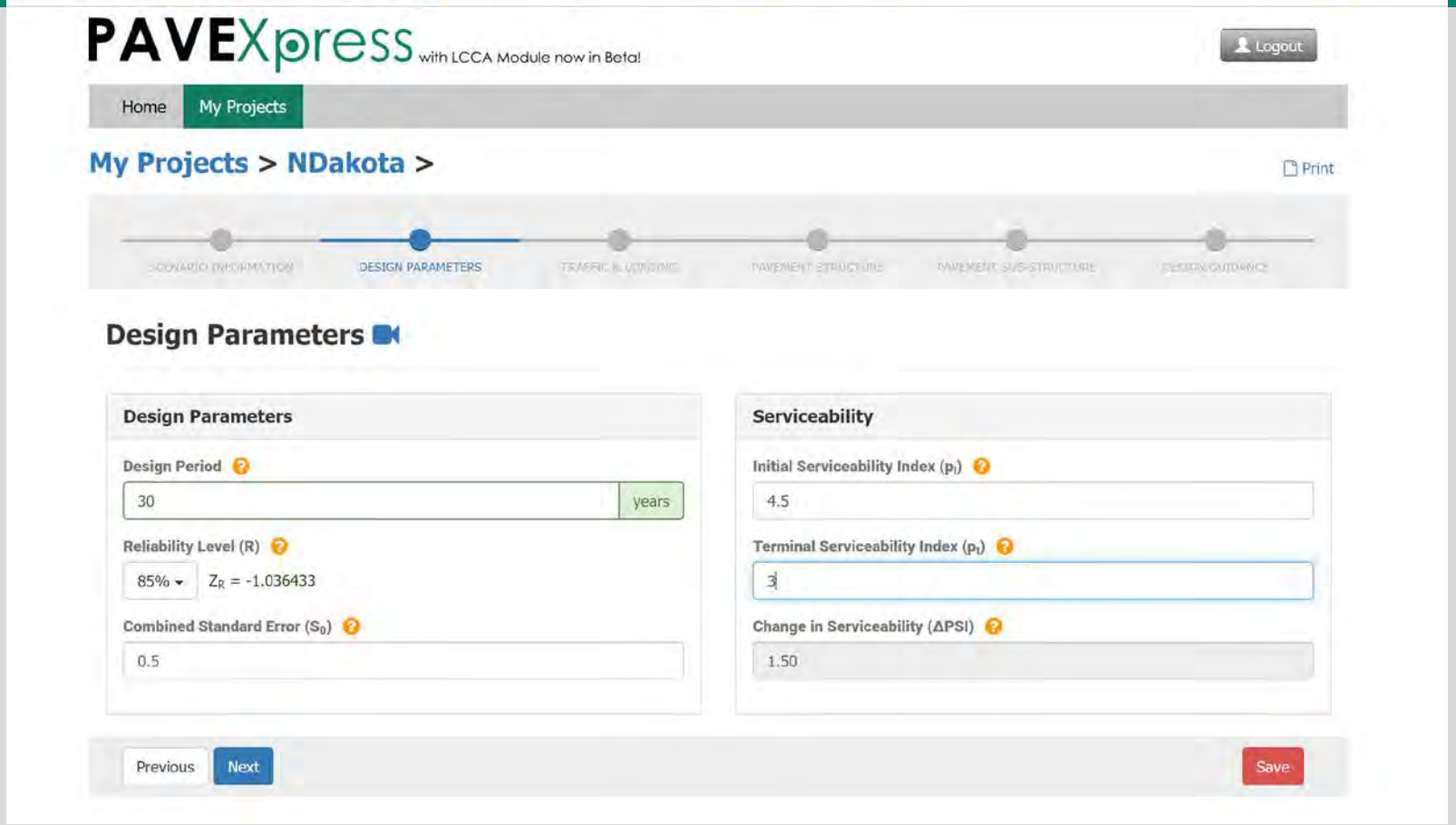
My Projects > NDakota > NDakota
Print
SCENARIO INFORMATION
Scenario Information
Scenario Information
Scenario Name
NDakota
Scenario Description
New Project
State
North Dakota
Pavement Design
Estimated Completion Year
2019
Roadway Classification
Arterials/Highway
Project Type
New - Asphalt

PAVEXpress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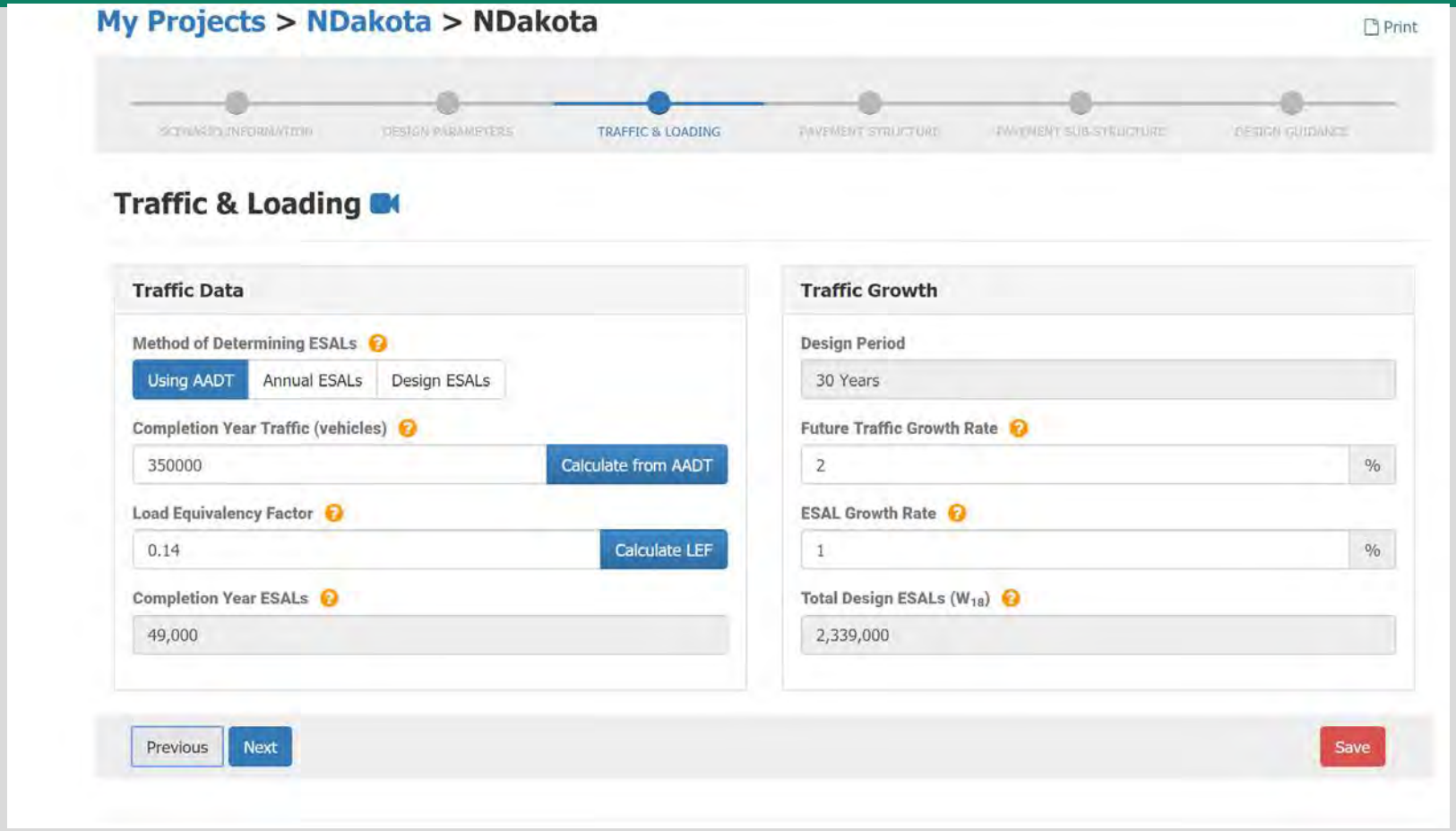
My Projects > NDakota >
Print
SCENARIO INFORMATION
DESIGN PARAMETERS
TRAFFIC & LOADING
PAVEMENT STRUCTURE
PAVEMENT SUB-STRUCTURE
DESIGN GUIDANCE
Design Parameters
Design Parameters
Design Period
30
years
Reliability Level (R)
85%
$Z_R$ = -1.036433
Combined Standard Error ($S_0$)
0.5
Serviceability
Initial Serviceability Index ($p_i$)
4.5
Terminal Serviceability Index ($p_t$)
3
Change in Serviceability (ΔPSI)
1.50
Previous
Next
Save

PAVEXpress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Print
SCENARIO INFORMATION
DESIGN PARAMETERS
TRAFFIC & LOADING
PAVEMENT STRUCTURE
PAVEMENT SUB-STRUCTURE
DESIGN GUIDANCE
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
Previous
Next
Save

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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Print

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

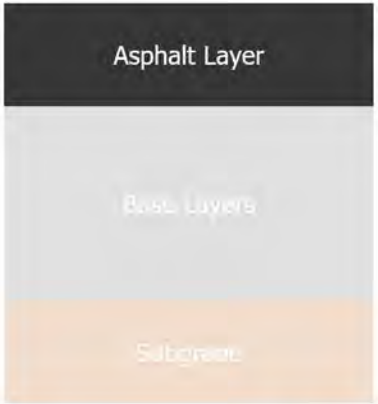
Drainage Coefficient (m)

1

Minimum Thickness

2 in

### Pavement Diagram




Previous Next Save

PAVEXpress

# Layer Coefficient Considerations

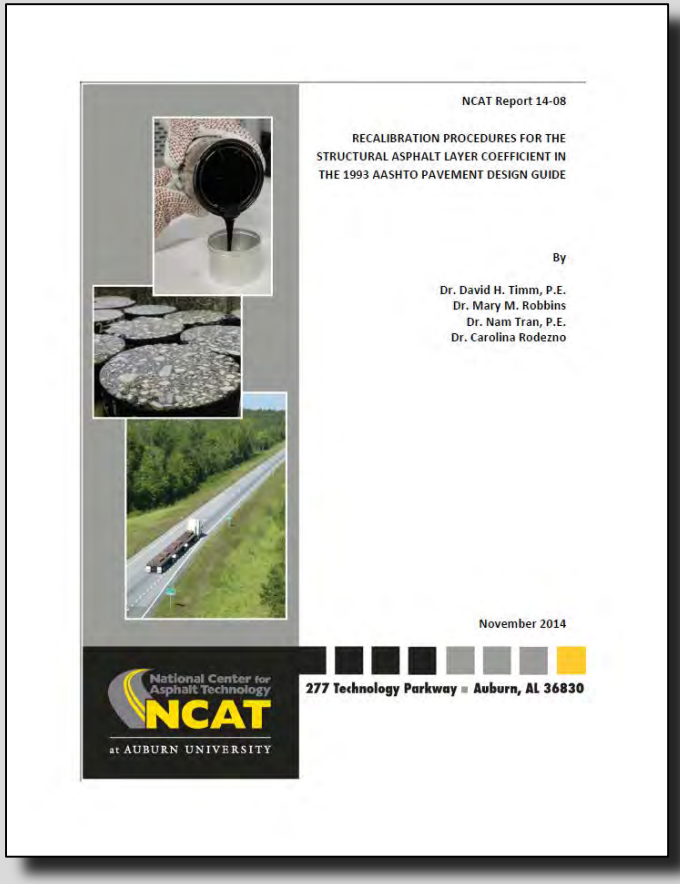
Average values of layer coefficients for materials used in the AASHO Road Test were as follows:

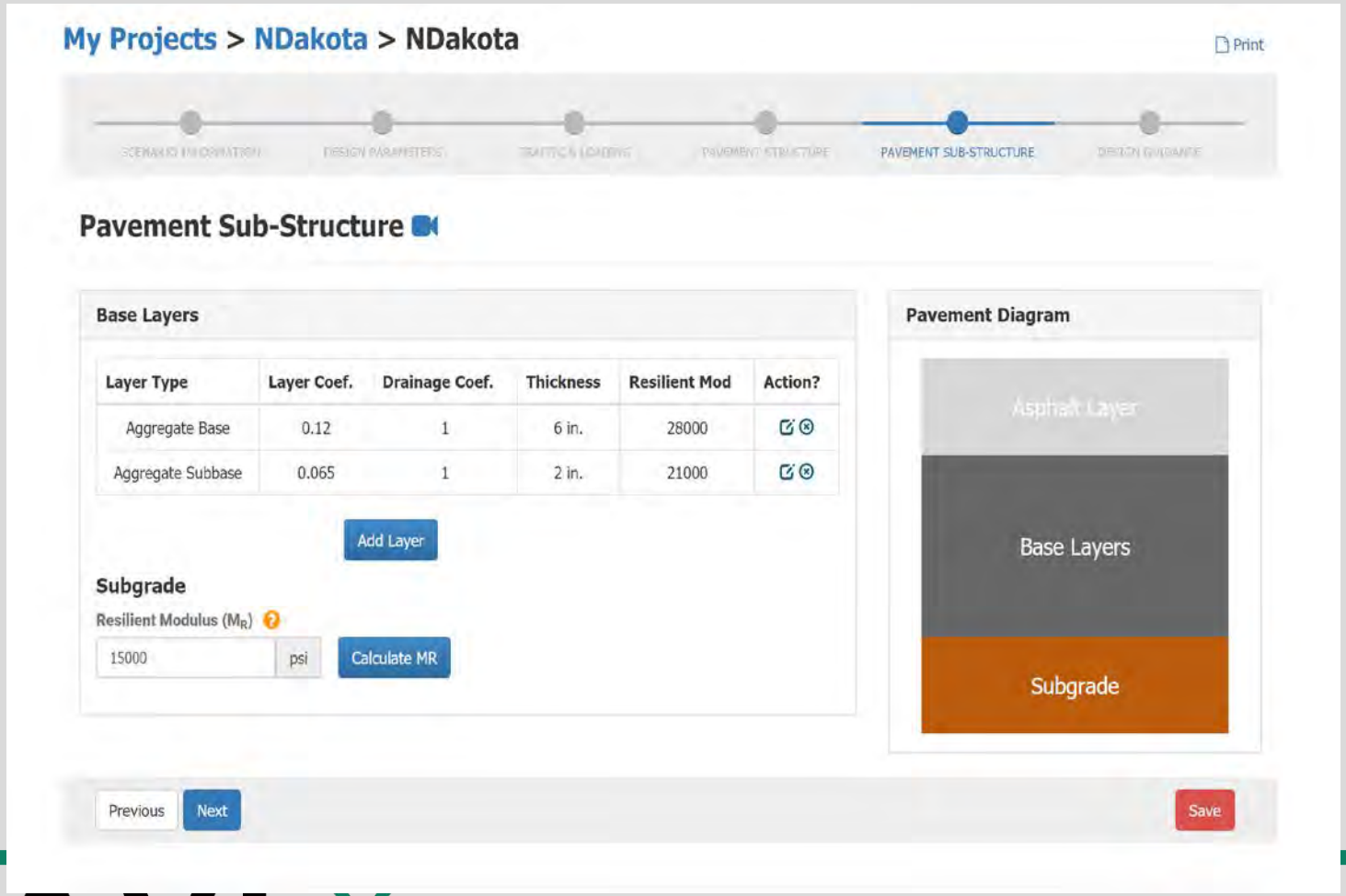
| | |
|---|---|
| Asphalt Surface Course | 0.44 |
| Crushed Stone Base Course | 0.14 |
| Sandy Gravel Subbase | 0.11 |

*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.

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Print
PAVEMENT SUB-STRUCTURE
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 (MR)
15000
psi
Calculate MR
Pavement Diagram
Asphalt Layer
Base Layers
Subgrade
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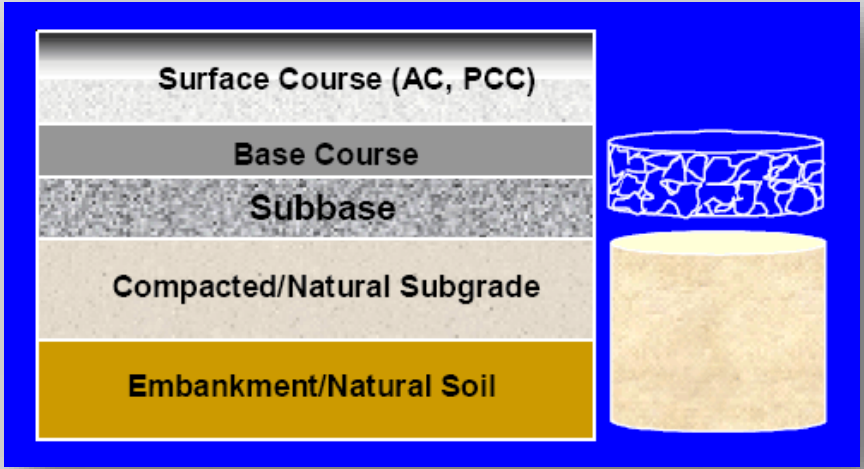
PAVExpress

# 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

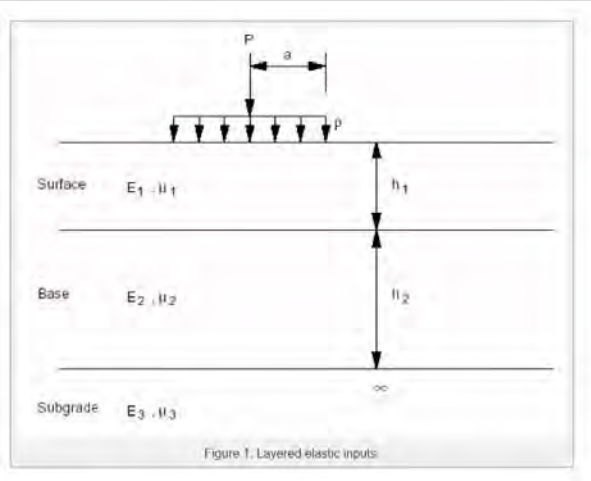

Figure 1. Layered elastic inputs

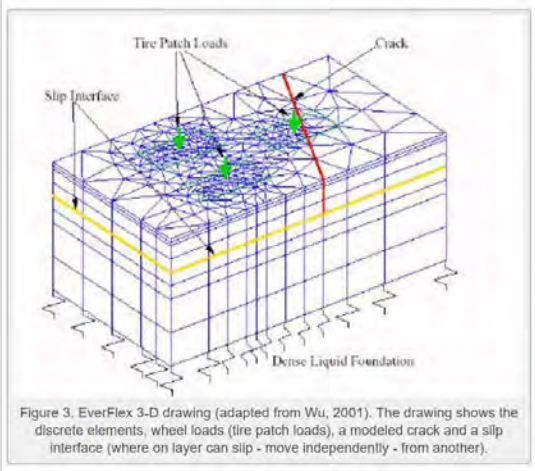

Figure 3. EverFlex 3-D drawing (adapted from Wu, 2001). The drawing shows the discrete elements, wheel loads (tire patch loads), a modeled crack and a slip interface (where on layer can slip - move independently - from another).

# Parking Lot Design Guidance

# Porous Pavement Design


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*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
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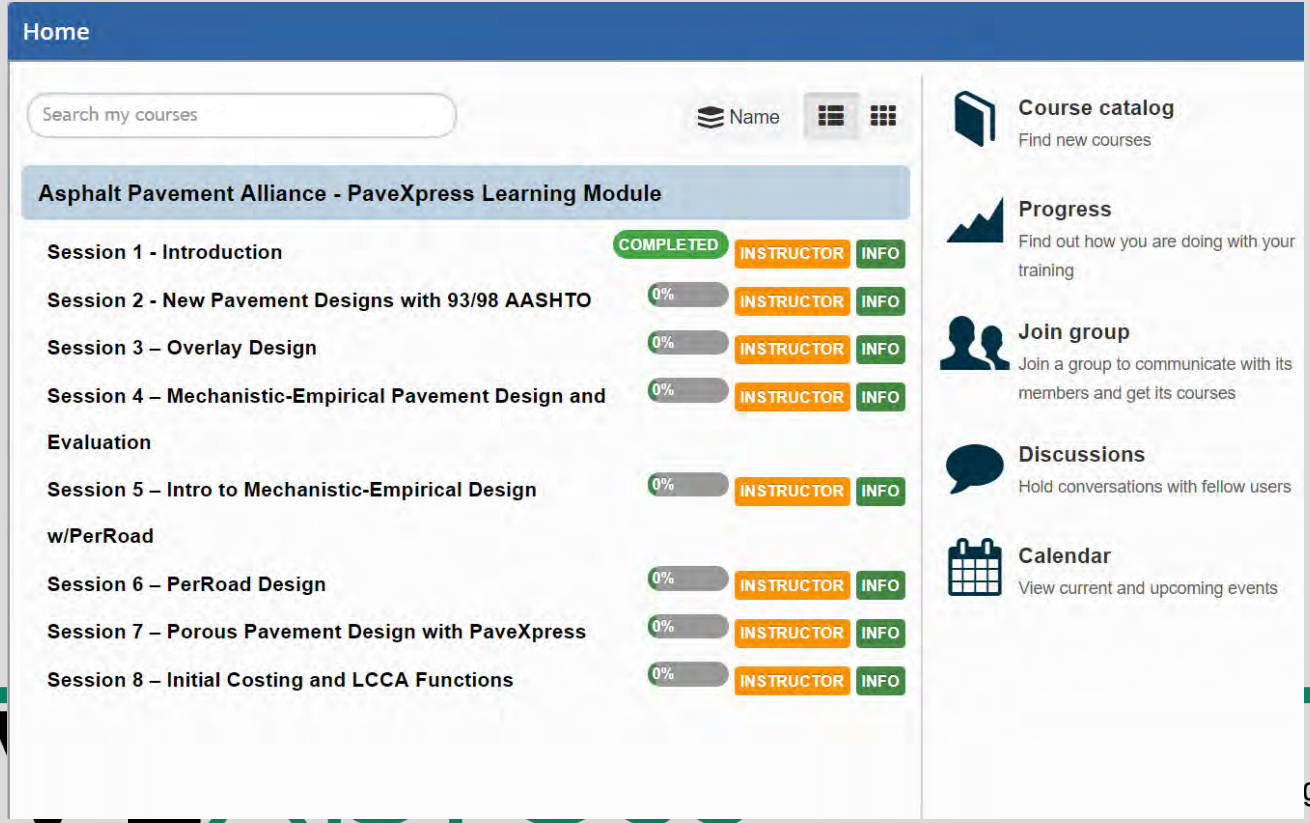


Mark as completed and continue

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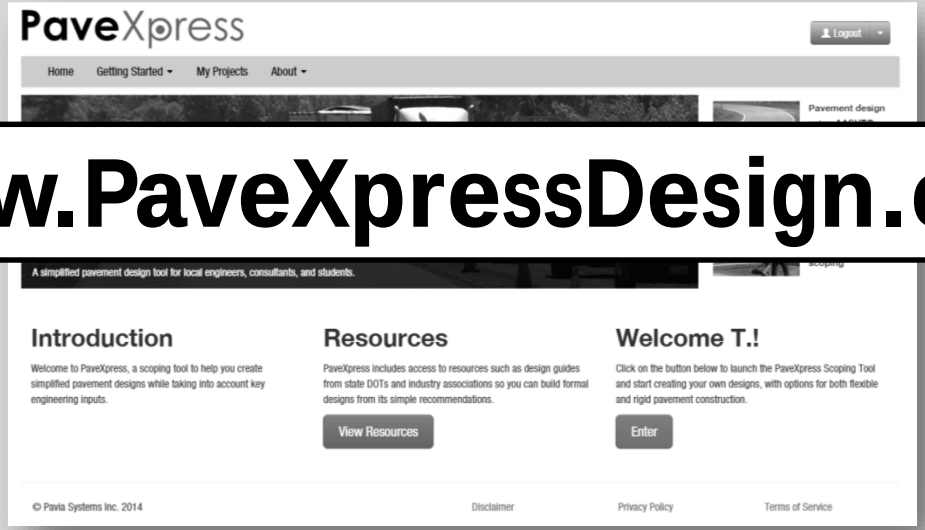
# So What Is Coming Next?

# Next Version Features

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

# PaveXpress

*A Simplified Pavement Design Tool*

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# Thank you!

# women of asphalt

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