

PaveXpress

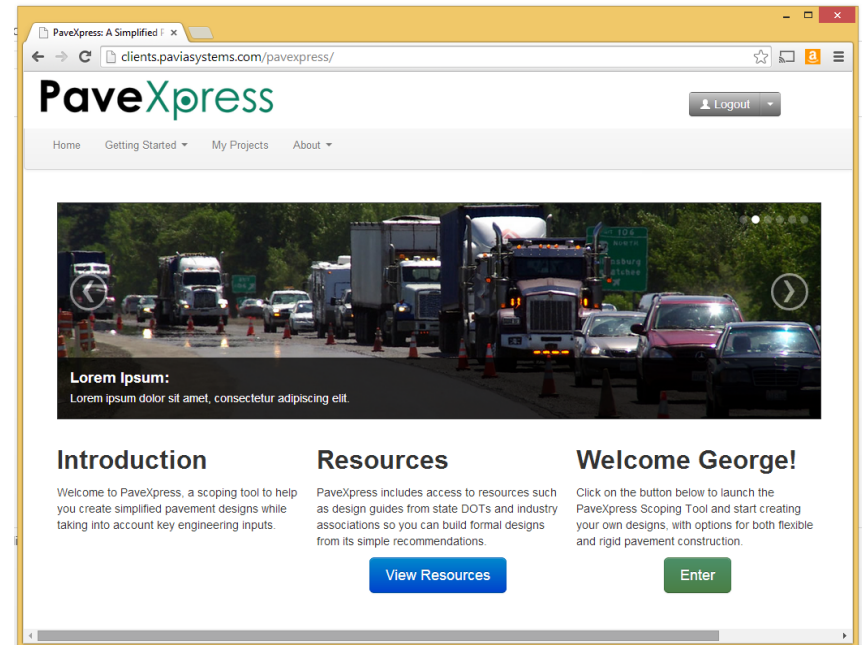
A Simplified Pavement Design Tool



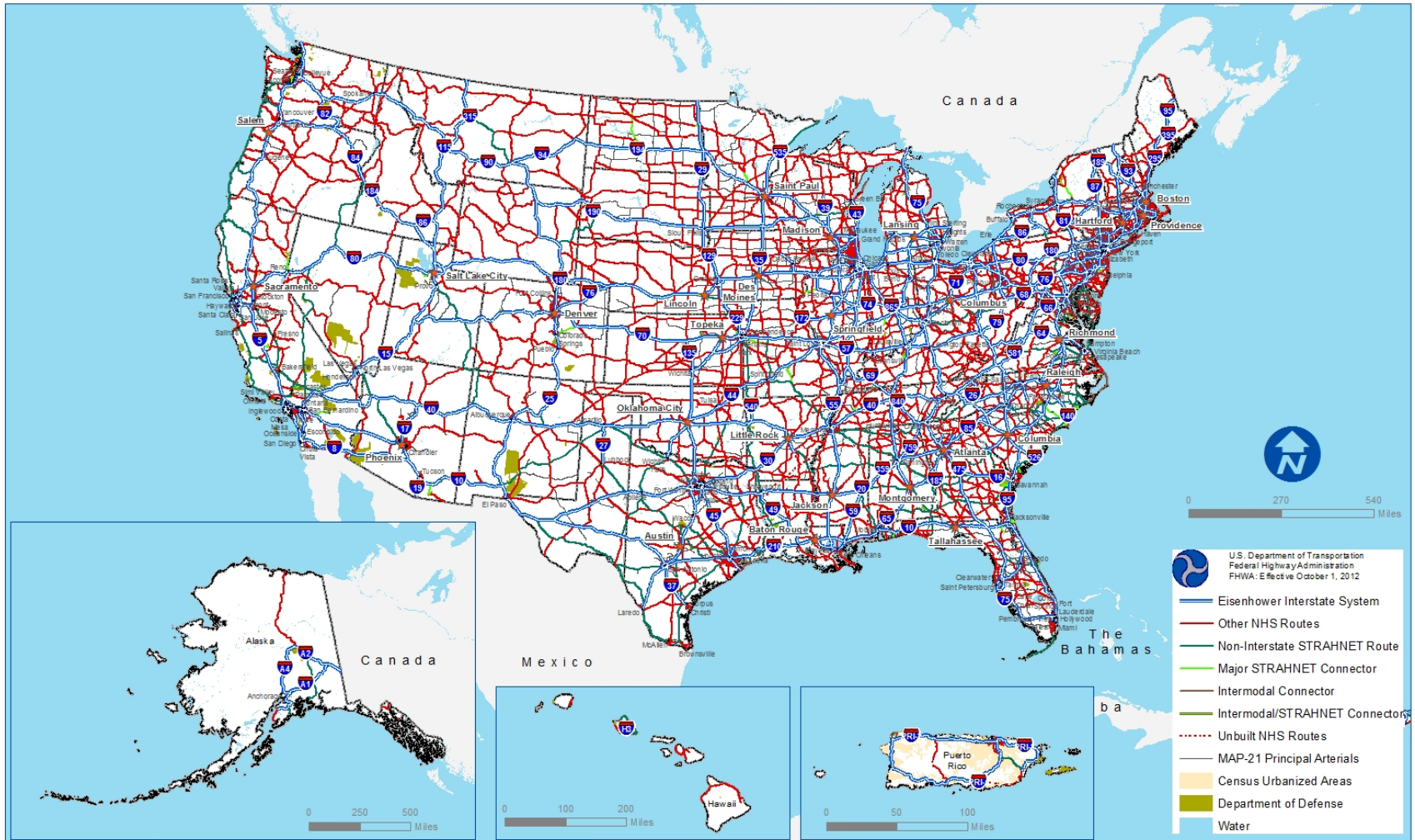
WAPA Annual Conference
December 2014

Today's Agenda

- Why PaveXpress?
- An Introduction
- Overview of system
- Design scenarios using *PaveXpress*
- What is happening next

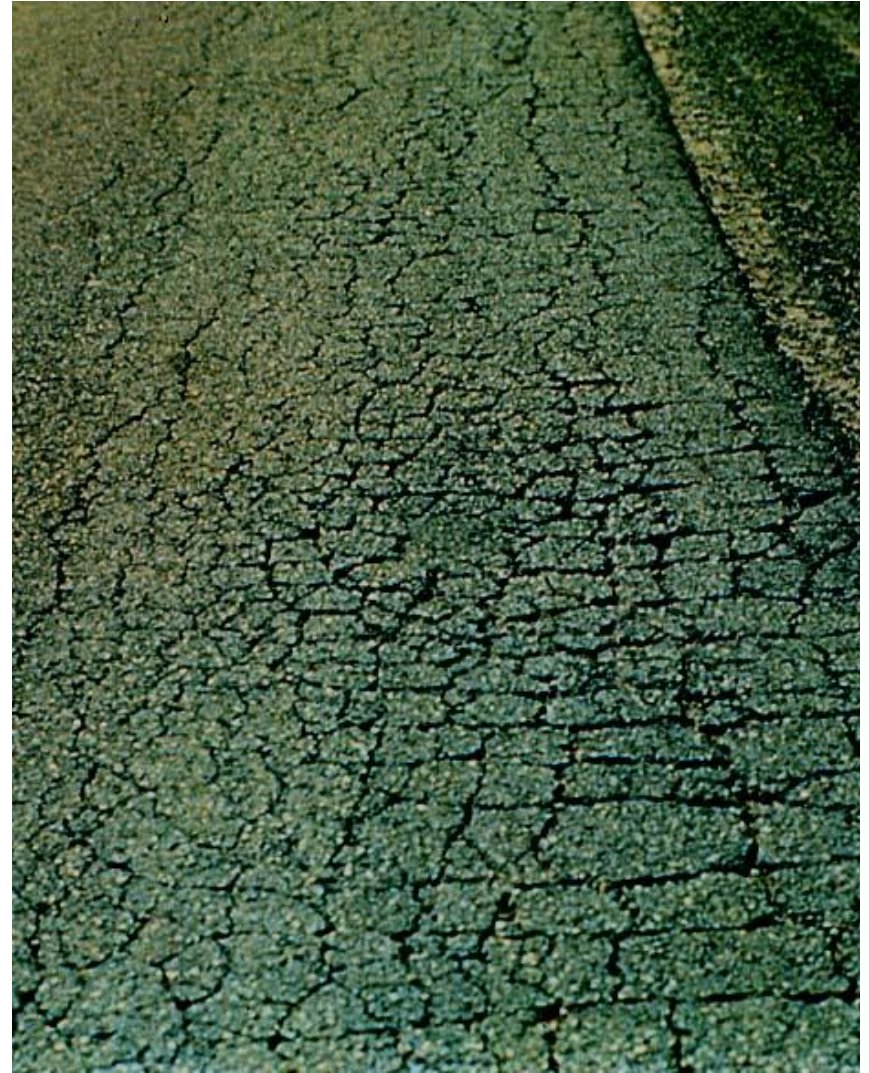


National Highway System

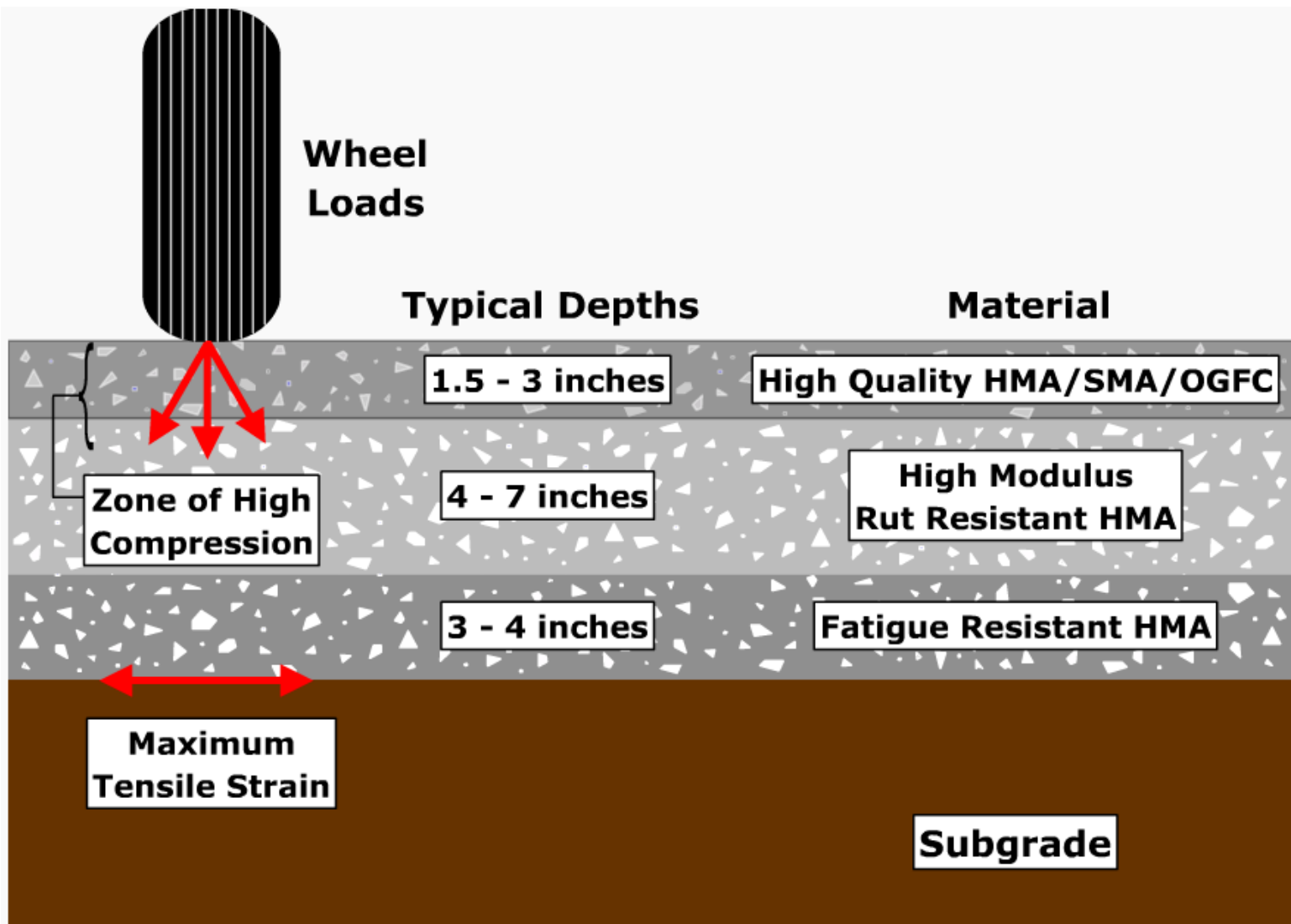


We've got a lot of roads

<http://www.fhwa.dot.gov/planning/images/thnhsjpg.jpg>

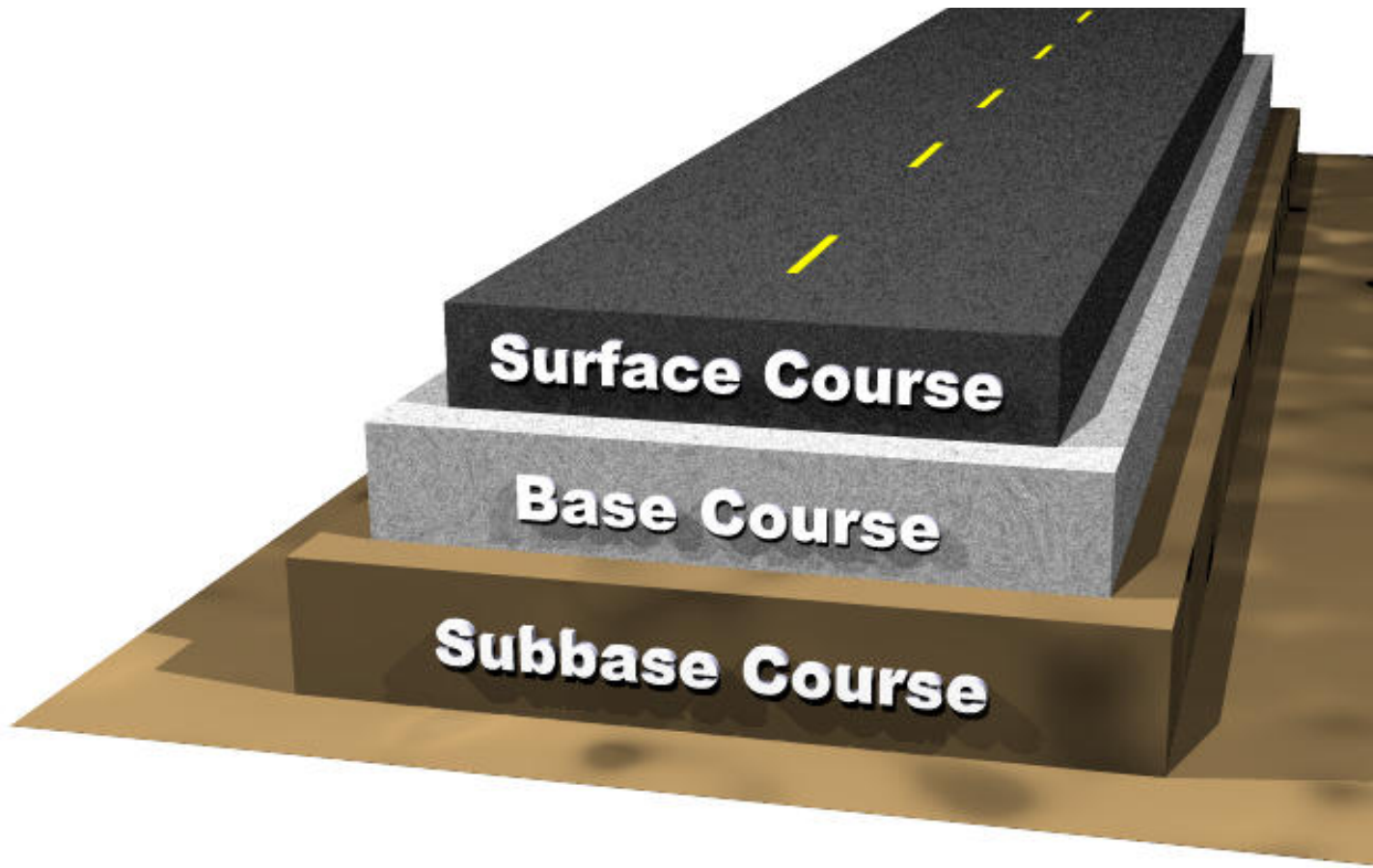


Examples of over and under-designed pavement abound



Perpetual pavement design

Pavement Interactive



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

Pavement Interactive

PaveXpress Objectives

- Provide tool to develop technically sound pavement designs for roadway pavements
- Provide a user-friendly, visually appealing, pavement design tool accessible to users on a variety of devices
- Provide a free application for conducting pavement designs following 1993/1998 AASHTO
- Provide resources to enhance understanding and comfort with asphalt pavement design

Target Audience

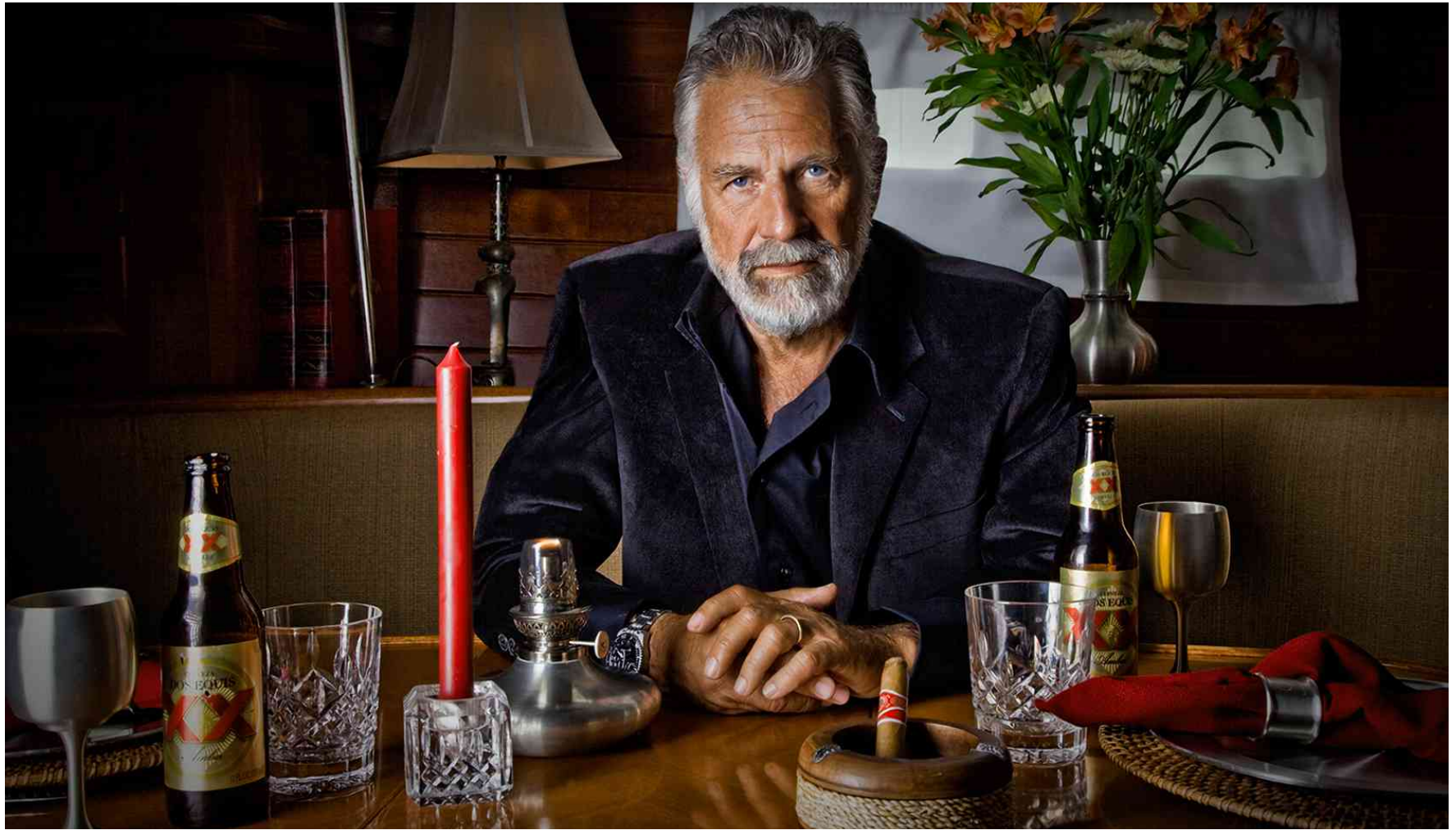
- Local Agencies
- A/E/C Firms
- Engineering Students

**Non-Pavement Design
Specific Engineers!**



Guiding Principles

- Provide accurate un-biased results...**be a trusted resource**
- Only ask the user for what is required to perform a technically sound design
- Where appropriate suggest industry accepted defaults to minimize user input
- Provide context sensitive help and guidance
- Assume users aren't pavement design experts

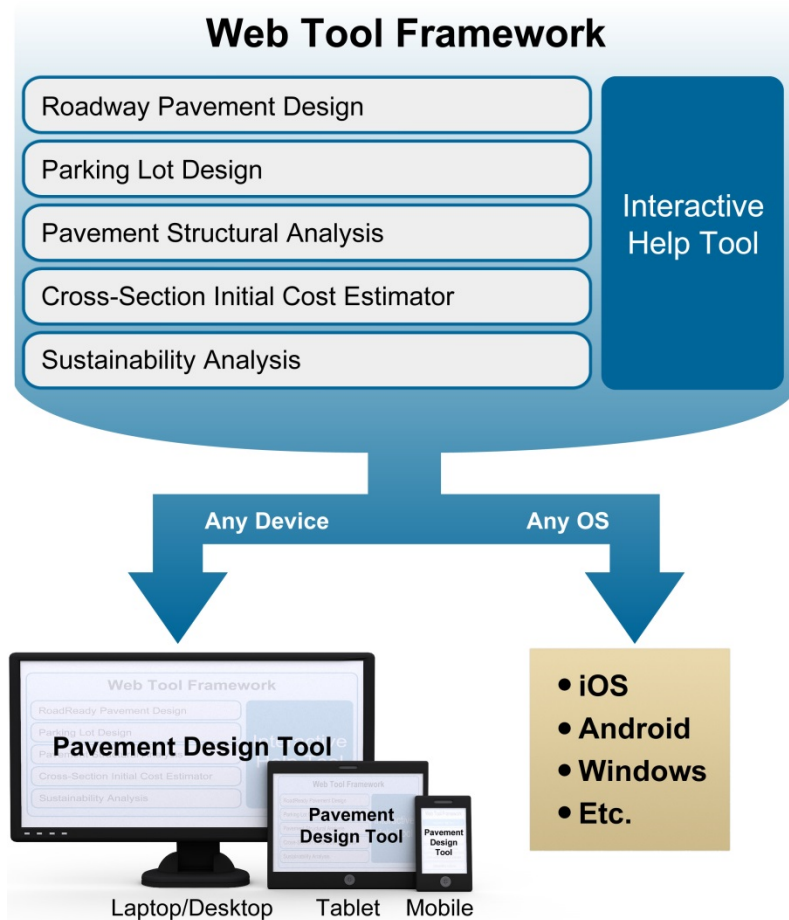


**I don't always do pavement designs,
but when I do, I prefer PaveXpress.**

Image from themostinterestingblogintheworld.com

paviasystem

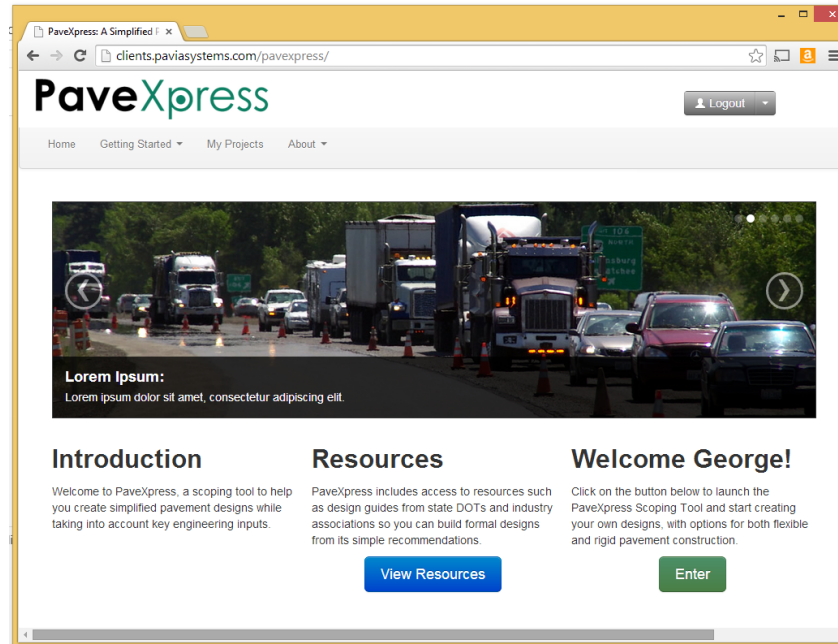
Approach: Web Delivery



- Browser based delivery
- Available via the web
- Supports all kinds of devices/OS
 - Desktops
 - Laptops
 - Tablets (7" – 10" - includes iPad Mini on up.
 - Handheld device capabilities
- Easily scalable and updatable

Approach: Technical

- Provide technically sound designs using:
 - Flexible: AASHTO '93
 - Rigid: AASHTO '93 w/ '98 Supplement
 - Parking lot guidance (Flexible only)
- Use industry accepted standards and guidance
- Linkages to State and Local guidance
- Linkages to Pavement Interactive



A sneak preview at some of the highlights.

LET'S TAKE A CLOSER LOOK!



Welcome to PaveXpress

A simplified pavement design tool for flexible and rigid pavements using AASHTO 93/98.

Introduction

Welcome to PaveXpress, a scoping tool to help you create simplified pavement designs while taking into account key engineering inputs.

Resources

PaveXpress includes access to resources such as design guides from state DOTs and industry associations so you can build formal designs from its simple recommendations.

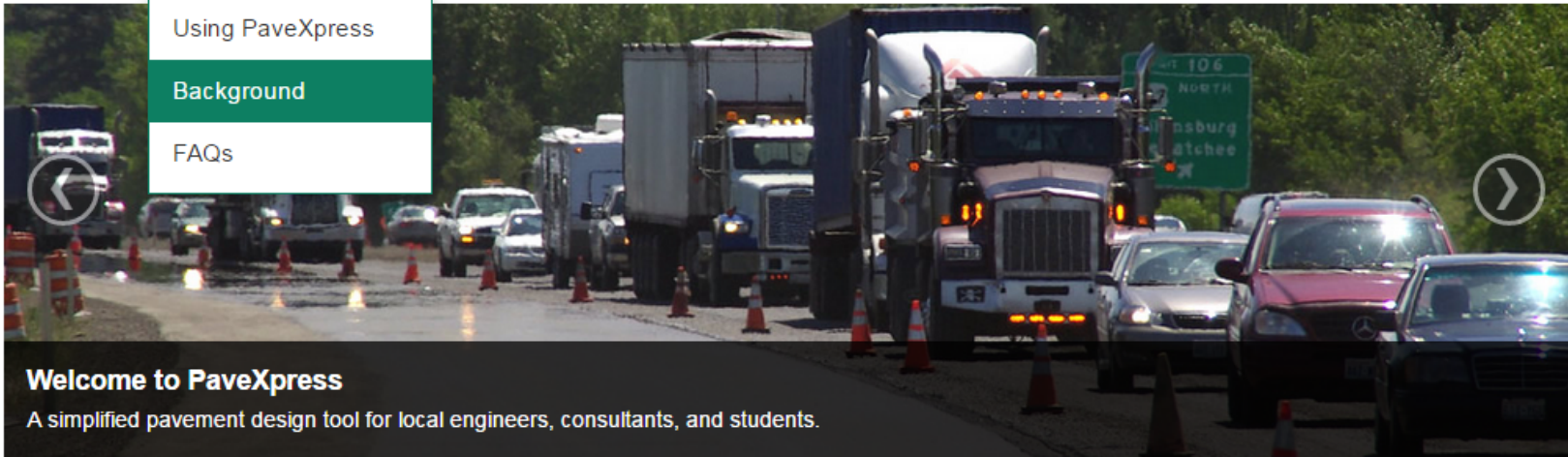
[View Resources](#)

Get Started

Click on the button below to launch the PaveXpress Scoping Tool and start creating your own designs, with options for both flexible and rigid pavement construction.

[Launch](#)

Home page: Welcome to PaveXpress

[Using PaveXpress](#)[Background](#)[FAQs](#)

Welcome to PaveXpress

A simplified pavement design tool for local engineers, consultants, and students.

Introduction

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Navigation up top, resources to familiarize you

Background

[Flexible](#)[Rigid](#)

1993 AASHTO Flexible Pavement Structural Design

[Empirical equations](#) are used to relate observed or measurable phenomena (pavement characteristics) with outcomes (pavement performance). This article presents the 1993 AASHTO *Guide* basic design equation for flexible pavements. This empirical equation is widely used and has the following form:

$$\log_{10}(W_{18}) = Z_R \times S_0 + 9.36 \times \log_{10}(SN + 1) - 0.20 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.2 - 1.5}\right)}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$$

These variables will be further explained in the Inputs section

Where:

W_{18}

predicted number of 80 kN (18,000 lb.) ESALs

Background Information is available

Design

Design » Structural Design » AASHTO Road Test

AASHTO Road Test

Publish date: August 13, 2007 | Author: Pavement Interactive

Print Cite Email This

The AASHTO Road Test, a \$27 million (1960 dollars) investment and the largest road experiment of its time, was conceived and sponsored by the American Association of State Highway Officials (AASHTO) as a study of the performance of highway pavement structures of known thickness under moving loads of known magnitude and frequency (Highway Research Board, 1961[1]). The test studied both portland cement concrete and asphaltic concrete pavements, as well as certain types of short-span bridges.

The information obtained from the AASHTO Road Test was crucial in advancing knowledge of pavement [structural design](#), [pavement performance](#), [load equivalencies](#), [climate effects](#), and much more. The basic performance information resulted in the performance equations and nomographs used in the AASHTO *Guide*. This section provides some background information on the AASHTO Road Test. It should be helpful in understanding the experiment's strengths, weaknesses and limitations.

Background

This section provides some of the basic background for the AASHTO Road Test and is taken primarily from Highway Research Board's Special Report 61A, *The AASHTO Road Test: History and Description of the Project* (1961).

Sponsors

Pavement Tool Consortium



Linked and integrated to Pavement Interactive

FAQ

What data do I need to have ready in order to use the tool?

You should know the intended design life of the pavement, have traffic counts in order to determine loads, and have an idea of what layer types to include in the pavement structure. Many of the tool inputs can be based on estimates or use default values provided by the tool itself.

How is the output of the tool provided?

The tool will generate a recommended structural design and layer thicknesses for the pavement structure being scoped. In addition, the tool can provide you with additional resources to review for design guidance.

Can this substitute for a formal design program such as DARWin-ME?

PaveXpress is designed as a scoping tool so that users can quickly scope potential pavement designs based on minimal input requirements. The tool applies standard design equations to generate its recommendations, but is not a replacement for an agency's formal design process.

Does the tool use a mechanistic-empirical design process?

The design equations used by the scoping tool are empirical in nature. Additional features to incorporate mechanistic inputs are currently being considered.

Frequently asked questions

Launch App

Registered User?

Email

Password

[Forgot Password?](#)

Need an Account?

Name

Email

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Get Started

Click on the button below to launch the PaveXpress Scoping Tool and start creating your own designs, with options for both flexible and rigid pavement construction.

You must register with email and password.

Folders

My Projects











 Common designs  

 Parking Lot #1  

 Local Route 123  

Projects

[Compare Selected \(0\)](#)

	Name	Created	Last Update	Type	Actions
<input type="checkbox"/>	Local Route 123 (rigid)	Sep 30 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Local Route 123 (flex)	Oct 16 2014	Oct 16 2014	pavexpress	    

Once logged in, go to My Projects to view your designs

Folders +

- My Projects
 - Common designs
 - Parking Lot #1
 - Local Route 123









New Folder

Folders allow you to group and categorize projects.

Folder Name

Parent Folder

Compare Selected (0)

update	Type	Actions
2014	pavexpress	   
2014	pavexpress	   

Create and manage your folders of designs

Folders

My Projects










 Common designs  

 Parking Lot #1  

 Local Route 123  

Projects

[Compare Selected \(0\)](#)

	Name	Created	Last Update	Type	Actions
<input type="checkbox"/>	Local Route 123 (rigid)	Sep 30 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Local Route 123 (flex)	Oct 16 2014	Oct 16 2014	pavexpress	    

Create a new project and design at the click of a button

Folders +

- My Projects
 - Common designs
 - Parking Lot #1
 - Local Route 123

Compare Selected (0)

New Project

Create a new project to begin entering information.

Project Name

Parent Folder

Project Type

update	Type	Actions
2014	pavexpress	
2014	pavexpress	

Give it a name and location

Sample Project

Save Print

- 1 Project Information**
Location, Roadway Classification and Pavement Type
- 2 Design Parameters**
Specific Design Variables
- 3 Traffic Data**
Traffic and Loading Data
- 4 Pavement Structure**
Pavement Layer(s) Information
- 5 Pavement Sub-Structure**
Base, Sub-Base and Subgrade
- Calculated Design**

Project Information

Project Name

Project Description

Estimated Completion Year ⓘ

Location

State ⓘ

Category

Roadway Classification ⓘ

Pavement Type ⓘ

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A clean, step wise process for creating the design

Sample Project

Save Print

- 1 Project Information**
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- Calculated Design**

Project Information

Project Name

Project Description

Estimated Completion Year ⓘ

Location

State ⓘ

Category

Roadway Classification ⓘ

Pavement Type ⓘ

Next

1. Start with general project information, locations

Sample Project

[Save](#) [Print](#)

1 Project Information

Location, Roadway Classification and Pavement Type

2 Design Parameters

Specific Design Variables

3 Traffic Data

Traffic and Loading Data

4 Pavement Structure

Pavement Layer(s) Information

5 Pavement Sub-Structure

Base, Sub-Base and Subgrade


Calculated Design

Design Parameters


Design Period (Years) 


Reliability

Reliability Level (R) $Z_R = -0.674$ 

Combined Standard Error (S_0) 

Serviceability

Initial Serviceability Index (p_i) 


Terminal Serviceability Index (p_t) 

Change in Serviceability (ΔPSI) 

[Previous](#)[Next](#)

2. Expand into design parameters

Sample Project

- 1 **Project Information**
Location, Roadway Classification and Pavement Type
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Specific Design Variables
- 3 **Traffic Data**
Traffic and Loading Data
- 4 **Pavement Structure**
Pavement Layer(s) Information
- 5 **Pavement Sub-Structure**
Base, Sub-Base and Subgrade
-  **Calculated Design**

Design Parameters


Design Period (Years)


Reliability


Reliability Level (R) $Z_R = -0.674$


Combined Standard Error (S_D) 

Serviceability

Initial Serviceability Index (p_i) 

Terminal Serviceability Index (p_t) 

Change in Serviceability (ΔPSI) 

 Logout ▾

The probability that a pavement section designed using the process will perform satisfactorily over the traffic and environmental conditions for the design period. This is then used to lookup Z_R , the standard normal deviate which is the standard normal table value corresponding to a desired probability of exceedance level.

The levels of reliability for various Functional Classifications (from AASHTO, 1993) are:

Func. Class	Recommended Reliability	
	Urban	Rural
Interstate or Freeway	85 - 99.9	80 - 99.9
Arterials	80 - 99	75 - 95
Collectors	80 - 95	75 - 95
Local	50 - 80	50 - 80

[Learn More](#)

Previous

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Context sensitive help linked to resources throughout

Sample Project

Save Print

- 1 **Project Information**
Location, Roadway Classification and Pavement Type
- 2 **Design Parameters**
Specific Design Variables
- 3 **Traffic Data**
Traffic and Loading Data
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Pavement Layer(s) Information
- 5 **Pavement Sub-Structure**
Base, Sub-Base and Subgrade
-  **Calculated Design**

Traffic Data

Completion Year Traffic (vehicles)	<input type="text" value="Traffic"/>	<input type="button" value="Calculate from AADT"/>	
Load Equivalency Factor	<input type="text" value="LEF"/>	<input type="button" value="Calculate LEF"/>	
Completion Year ESALs	<input type="text" value="0"/>		
Design Period	<input type="text" value="20 Years"/>		
ESAL Growth Rate	<input type="text" value="0"/> %		
Total Design ESALs (W_{18})	<input type="text" value="0"/>		

Previous Next

Enter traffic and loading information

Calculate Traffic from AADT ×

Use this page to calculate the completion year traffic level using a historical AADT value. The Directional and Lane adjustment factors come from AASHTO (93). [Learn More](#)

Average Annual Daily Traffic (AADT) ⓘ

Lanes Measured (AADT × 1.0) ⓘ

Directional Lanes (AADT × 1.0) ⓘ

Year of Traffic Count ⓘ

Traffic Growth Rate ⓘ

Completion Year Traffic ⓘ

Home

Sample

- 1 Proj
Locat
Paver
- 2 Desi
Speci
- 3 Traf
Trafic
- 4 Pav
Paver
- 5 Pav
Base,

Calculated Design


Logout

Save Print






Calculate traffic from AADT using AASHTO methods

Sample Project

Save Print

- 1 **Project Information**
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-  **Calculated Design**

Traffic Data



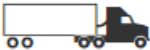
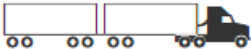

Completion Year Traffic (vehicles)	<input type="text" value="547500"/>	Calculate from AADT	
Load Equivalency Factor	<input type="text" value="LEF"/>	Calculate LEF	
Completion Year ESALs	<input type="text" value="0"/>		
Design Period	<input type="text" value="20 Years"/>		
ESAL Growth Rate	<input type="text" value="0"/> %		
Total Design ESALs (W_{18})	<input type="text" value="0"/>		

Previous Next

Completion year traffic is set, now on to LEF

Calculate Load Equivalency Factor

Use this dialog to establish the Composite Load Equivalency Factor for your project section. The values are used to then determine the ESALs from the vehicle count provided earlier. Default values suggested are from Washington State DOT.

	% of Traffic	Weighted Load Equivalency Factor (LEF)
	90 %	0.0001
	1 %	0.4
	8 %	1
	0 %	1.75
	1 %	0.4
Total	100 %	

Load Equivalency Factor 0.0881


Cancel

Set LEF and Close

Create composite load equivalency factor

Sample Project

Save Print

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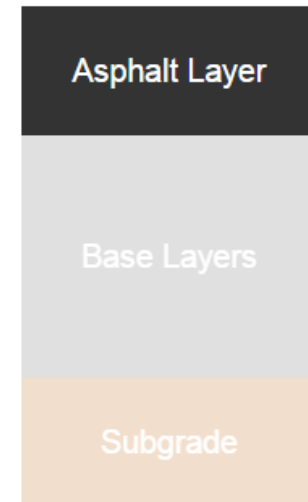
Pavement Structure (Flexible) (Asphalt)

Use Multiple Lifts ⓘ

Layer Coefficient (a) ⓘ

Drainage Coefficient (m) ⓘ

Minimum Thickness ⓘ



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Specify your surface layer information

PaveXpress

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Sample Project

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Base, Sub-Base and Subgrade

Calculated Design

Asphalt Layer

Base Layers

Subgrade

Drainage Coefficient (m) ⓘ

Minimum Thickness in ⓘ

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Drainage Coefficient Warning

Be careful when using layer drainage coefficients other than 1.0. If a fundamental drainage problem is suspected, thicker layers may only be of marginal benefit - a better solution is to address the actual drainage problem by using very dense layers (to minimize water infiltration) or designing a drainage system. Do you still want to adjust this value?

Cancel Accept

Warnings where appropriate to alert of changes

Sample Project

Save Print

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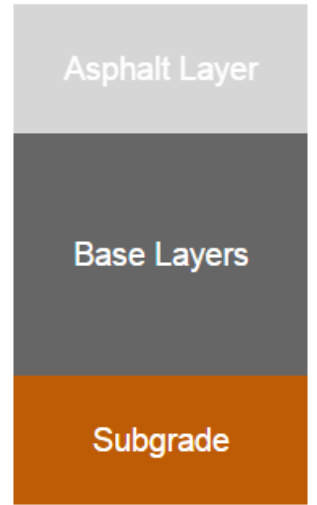
Base Layers

Layer Type	Layer Coef.	Drainage Coef.	Thickness	Action?
Click on the Add Layer button below to add a Base Layer.				

Add Layer

Subgrade

Resilient Modulus (M_R) psi *i*



Previous Next

Enter your base layer and subgrade information

PaveXpress

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Save Print

Sample Project

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Base, Sub-Base and Subgrade

Calculated Design

Add Base Layer

Layer Type: Granular Base

Layer Coefficient: 0.14

Drainage Coefficient: 1

Thickness: 6 in

Cancel Add Layer

Subgrade

Resilient Modulus (M_R): Enter Subgrade psi

Asphalt Layer

Base Layers

Subgrade

Previous Next



Add multiple base layers if needed

Sample Project

Save Print

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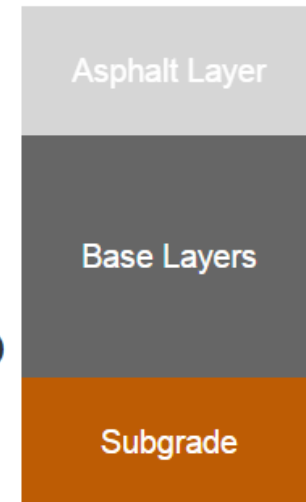
Base Layers

Layer Type	Layer Coef.	Drainage Coef.	Thickness	Action?
Granular Base	0.14	1	6 in.	 

Add Layer

Subgrade

Resilient Modulus (M_R)

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And enter your subgrade...can use conversion tables

Sample Project

Save Print

1 Project Information
Location, Roadway Classification and Pavement Type

2 Design Parameters
Specific Design Variables

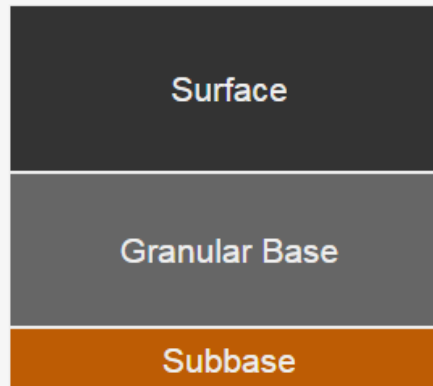
3 Traffic Data
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4 Pavement Structure
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Calculated Design

Scoped Design



Required minimum design SN:
3.65

Layer Thicknesses (in)

Surface: 6.50

Granular Base: 6.00

Total SN: 3.70

[See Calculation Details](#)

Resources



Washington Asphalt Pavement Association

Previous

And voila...a design and resources are available

Calculation Details

Resilient Modulus (M_R)	=	6000 psi
Minimum Required Structural Number (SN_{Req})	=	3.65
SN	=	Layer Coef (a) * Drainage Coef (m) * Layer Thickness (D)

Known Layer Contributions

$SN_{Granular\ Base}$	=	0.84
-----------------------	---	------

$SN_{Asphalt} = SN_{Req} - SN_{Known\ Layers}$	=	2.81
Calculated $D_{Asphalt}$ (rounded to the nearest 1/2")	=	6.5"
Calculated Total SN	=	3.70
Calculated Total Asphalt Layer depth	=	6.50"

Subbase

[See Calculation Details](#)

Resources



Washington Asphalt Pavement Association

Previous

And the calculations are shown

Sample Project

Save Print

1 Project Information
Location, Roadway Classification and Pavement Type

2 Design Parameters
Specific Design Variables

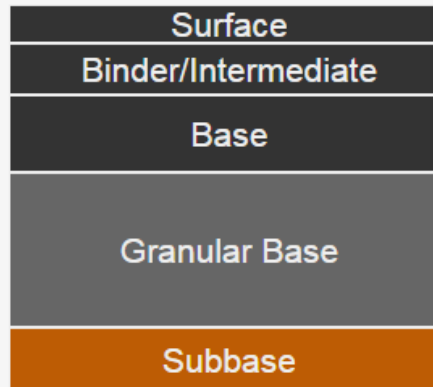
3 Traffic Data
Traffic and Loading Data

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Calculated Design

Scoped Design



Required minimum design SN:
3.65

Layer Thicknesses (in)

Surface: 1.50
Binder/Intermediate: 2.00
Base: 3.00
Granular Base: 6.00

Total SN: 3.70

[See Calculation Details](#)

Resources



Washington Asphalt Pavement Association

Iterate back and forth to check sensitivity, add layers

Sample Project

Save Print

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Project Information

Project Name

Project Description

Estimated Completion Year ⓘ

Location

State ⓘ

Category

Roadway Classification ⓘ

Pavement Type ⓘ

Next

For Rigid, a similar process with a few alterations

- 1 Location, Roadway Classification and Pavement Type
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Specific Design Variables
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Base, Sub-Base and Subgrade
- Calculated Design

Design Period (Years) 20 *i*

Reliability

Reliability Level (R) 75 $Z_R = -0.674$ *i*

Combined Standard Error (S_0) 0.4 *i*

Serviceability

Initial Serviceability Index (p_i) 4.5 *i*

Terminal Serviceability Index (p_t) 3 *i*

Change in Serviceability (APSI) 1.5 *i*

Climate

Nearest City Nearest City *i*

Mean Annual Wind Speed 6.7 mph

Mean Annual Temperature 49.6 °F

Mean Annual Precipitation 51 in

Previous Next

Additional design parameters for weather

Sample Project

Save Print

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Pavement Structure (PCC)

Modulus of Rupture (S'_c) psi *i*

Elastic Modulus (E_c) psi *i*

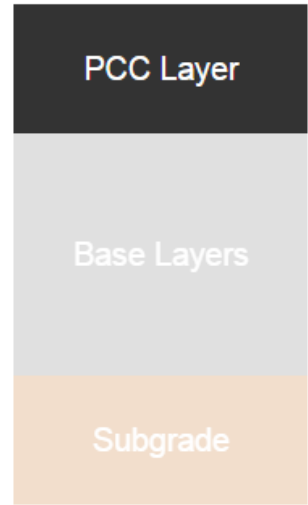
Poisson's Ratio (μ) *i*

Pavement Joint and Edges (PCC)

Joint Spacing (L) in *i*

Load Transfer Coefficient (J) *i*

Edge Support (E) *i*



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Specify the surface characteristics

Sample Project

[Save](#) [Print](#)


1 Project Information
Location, Roadway Classification and Pavement Type

2 Design Parameters
Specific Design Variables

3 Traffic Data
Traffic and Loading Data

4 Pavement Structure
Pavement Layer(s) Information

5 Pavement Sub-Structure
Base, Sub-Base and Subgrade

 **Calculated Design**

Pavement Sub-Structure (PCC)

Base Layer Type


Base Modulus (E_b) 

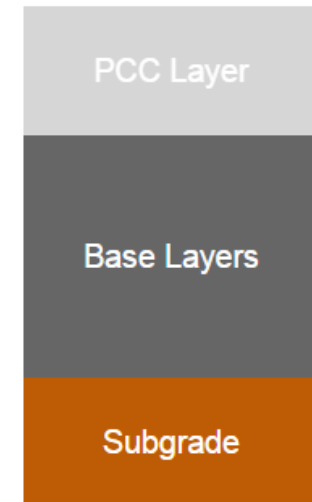
Base Thickness (H_b) 

Drainage Factor (C_d) 

Slab/Base Friction Coefficient 

Subgrade

Eff. Modulus of Subgrade Reaction (k) 

[Previous](#) [Next](#)

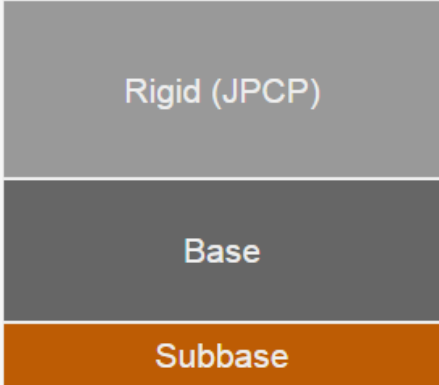
Specify the base characteristics

Sample Project

Save Print

- 1 Project Information**
Location, Roadway Classification and Pavement Type
- 2 Design Parameters**
Specific Design Variables
- 3 Traffic Data**
Traffic and Loading Data
- 4 Pavement Structure**
Pavement Layer(s) Information
- 5 Pavement Sub-Structure**
Base, Sub-Base and Subgrade
- Calculated Design**

Scoped Design



The diagram shows three stacked layers: a top grey layer labeled 'Rigid (JPCP)', a middle dark grey layer labeled 'Base', and a bottom orange layer labeled 'Subbase'.

Layer Thicknesses (in)

Rigid (JPCP): 7.5
Base: 6.00
[See Calculation Details](#)

Resources

Previous

And again, voila, a design is presented with calculations

Sample Project

Save

Print

1

Project Information

Location, Roadway Classification and Pavement Type



Calculated Design

Project Information

Project Name

Sample Project

Project Description

This is a test

Estimated Completion Year

2015



Location

State

Washington



Category

Roadway Classification

Parking Lot – Light Duty



Pavement Type

Flexible



Next

Parking lots you ask?

Sample Project

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1 Project Information

Location, Roadway Classification and Pavement Type

Calculated Design

Design

A structural pavement design is not necessary for light-duty parking lots. Cars and light duty trucks do not damage pavements; therefore, most states have a standard set of designs for these facilities. Please refer to the resources provided below for this type of pavement.

Resources



Washington Asphalt Pavement Association



Washington Asphalt Parking Lot Design Guide

[Previous](#)

Light duty points directly to local guidance (catalogs)



|| Latest News



Executive Update: Transportation is big election day winner

Posted [November 10, 2014](#)

The votes are tallied and the confetti swept away. In the wake of another closely watched election season, we wanted to take a closer look ...

[continue reading](#)

WELCOME TO WAPA

The nonprofit Wisconsin Asphalt Pavement Association represents Wisconsin's asphalt industry. This Web site is a resource for our members (some 80 contractors and manufacturers), their customers and the public at large. Make this your first stop for information on hot mix asphalt in Wisconsin.



UPCOMING EVENTS

Takes you to local guidance from WAPA

Folders

My Projects
















 Common designs  

 Parking Lot #1  

 Local Route 123  

Projects

[Compare Selected \(0\)](#)

	Name	Created	Last Update	Type	Actions
<input type="checkbox"/>	Local Route 123 (rigid)	Sep 30 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Local Route 123 (flex)	Oct 16 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Sample Project	Oct 27 2014	Oct 27 2014	pavexpress	    

Some other capabilities you should be aware of

Folders

My Projects
















 Common designs  

 Parking Lot #1  

 Local Route 123  

Projects

[Compare Selected \(0\)](#)

	Name	Created	Last Update	Type	Actions
<input type="checkbox"/>	Local Route 123 (rigid)	Sep 30 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Local Route 123 (flex)	Oct 16 2014	Oct 16 2014	pavexpress	    
<input type="checkbox"/>	Sample Project	Oct 27 2014	Oct 27 2014	pavexpress	    

Organize, store, and print your designs

Folders +

- My Projects
 - Common designs
 - Parking Lot #1
 - Local Route 123

Share Project Sample Project

Share a report with a friend by email
(they will receive an independent copy of this project)

Friend's Email*

Message*

Compare Selected (0)

update	Type	Actions
2014	pavexpress	
2014	pavexpress	
2014	pavexpress	

Share your design directly from PaveXpress via email

Roadway Classification	Local	Local	Local
Pavement Type	Rigid	Flexible	Flexible
Design Parameters			
Traffic Parameters			
Pavement Structure			
Design Recommendation			
Report Title	Local Route 123 (rigid)	Local Route 123 (flex)	Sample Project
Design Thickness	12.5"	11.5"	12.5"
Cross Section	Rigid (JPCP) 6.5"	Surface 5.50"	Surface 1.50"
			Binder/Intermediate 2.00"
	Base 6.00"	Granular Base 6.00"	Base 3.00"
			Granular Base 6.00"
	Subbase	Subbase	Subbase

Compare up to 3 designs side by side

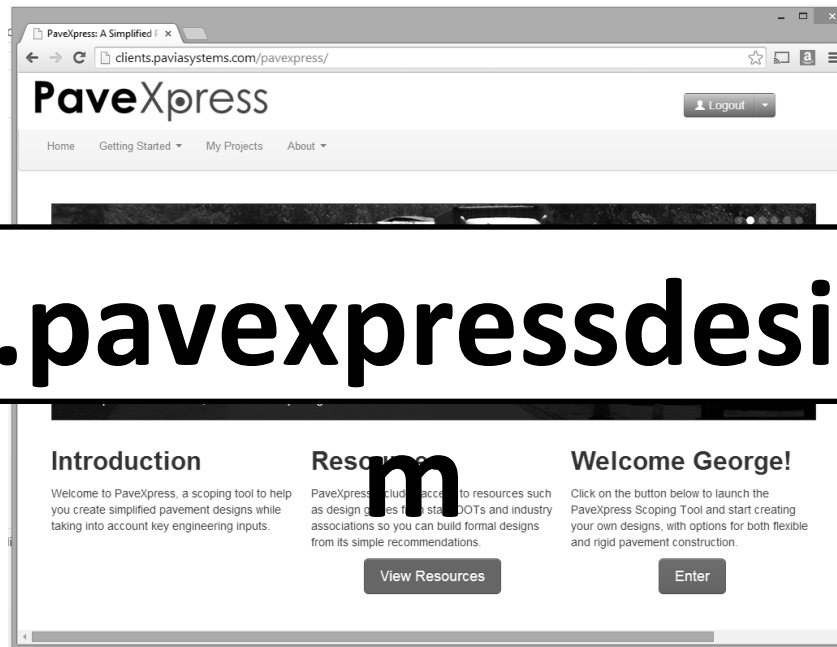
Future of *PaveXpress*

A framework to continue to build upon:

- Overlay design (empirical)
- Simplified mechanistic design for both new construction and overlays
- Comparison tools for mechanistic and empirical methods
- And more

PaveXpress

A Simplified Pavement Design Tool



www.pavexpressdesign.co

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paviasystem



PACKERS