



2018 Local Roads Workshop

#### PaveXpress Update

March 2018

Asphalt Pavement Association Michigan MICHIGAN RIDES ON US

Asphalt.

# PaveXpress

#### A Simplified Pavement Design Tool

## **Brief Overview**

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





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

### **PaveXpress**

# 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





#### **1993 AASHTO Design Guide Equation**



The equation was derived from empirical information obtained at the AASHO Road Test.

The solution represents the average amount of traffic that can be sustained by a roadway before deteriorating to some terminal level of serviceability, according to the supplied inputs.

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#### **1993 AASHTO Design Guide Equation**

 $\log_{10}(W_{18}) = Z_R \times S_0 + 9.36 \times \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$ 

#### Where:

- $W_{18}$  = the predicted number of 18-kip equivalent single axle load (ESAL) applications
- $Z_R$  = standard normal deviate
- $S_0$  = combined standard error of the traffic prediction and performance prediction
- $\Delta PSI$  = difference between the initial design serviceability index ( $p_i$ ) and the design terminal serviceability index ( $p_t$ )
- $M_R$  = resilient modulus of the subgrade (psi)

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#### **1993 AASHTO Design Guide Equation**

The designer inputs data for all of the variables except for the structural number (SN), which is indicative of the total pavement thickness required.

Once the total pavement SN is calculated, the thickness of each layer within the pavement structure is calculated

$$SN = a_1 D_1 m_1 + a_2 D_2 m_2 + a_3 D_3 m_3 + \dots + a_i D_i m_i$$

Where:

 $a_i = i^{\text{th}}$  layer coefficient  $D_i = i^{\text{th}}$  layer thickness (inches)  $m_i = i^{\text{th}}$  layer drainage coefficient

**PaveXpress** 

Home Getting Started - My Projects	About -			
Fraining - AC New Design			Save	
Project Information	Project Information			
Location, Roadway Classification and Pavement Type	Project Name	Training - AC New Design		
2 Design Parameters Specific Design Variables	Project Description	Project Description	1	
3 Traffic & Loading Traffic and Loading Data	Estimated Completion Year	YYYY <b>3</b>		
4 Pavement Structure Pavement Layer(s) Information	State Roadway Classification	Select a Roadway Classification •		
5 Pavement Sub-Structure Base, Sub-Base and Subgrade	Pavement Design	Select a Project Type -		
Design Guidance				
			Previous Next	
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### Screen 1

- 1) Project Name is an open field, allowing the user to input any desired information.
- 2) Description is an open field, allowing the user to input any desired information.
- 3) Estimated Completion Year field is used to extrapolate the growth in traffic that may occur while the project is being constructed. Traffic data inputs use data beginning in completion year.
- 4) State uses a drop-down box that allows the user to select the state.

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#### Screen 1

5) Roadway Classification drop-down box allows the user to indicate the functional classification that best describes how the pavement will be used. In PaveXpress, the selection affects default values for design period, reliability, and initial & terminal serviceability index. These default values can be overridden by the user.

Access control is a key factor in the realm of functional classification. For example, all Interstates are "limited access" or "controlled access" roadways. "Access" refers to the ability to access the roadway and not the abutting land. It is difficult to find hard-and-fast rules defining classifications, so some degree of judgment must be exercised here.



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#### **Project Information**

Location, Roadway Classification and Pavement Type

- 6) Project Type drop-down box allows the user to indicate the type of pavement being designed:
  - New Asphalt, 1993 AASHTO Design Guide
  - New Concrete, 1998 Supplement
  - AC Overlay on Asphalt, 1993 Guide
  - AC Overlay on Concrete or Composite





This presentation will focus on New Asphalt designs and AC Overlay on Asphalt designs

**PaveXpress** 

Home Cetting Started - My Brojects	About -				
				Save Print	
<ul> <li>Project Information Location, Roadway Classification and Pavement Type</li> <li>Design Parameters Specific Design Variables</li> </ul>	Design Parameters Design Period Reliability Reliability Level (R)	20 years 75 - Z	<b>i</b> a = -0.674 <b>i</b>		
<ul> <li>Traffic Data Traffic and Loading Data</li> <li>Pavement Structure Pavement Layer(s) Information</li> </ul>	Combined Standard Error (S <sub>0</sub> ) Serviceability Initial Serviceability Index (p <sub>i</sub> )	0.5 4.5	0		
5 Pavement Sub-Structure Base, Sub-Base and Subgrade	Terminal Serviceability Index (p <sub>i</sub> ) Change in Serviceability (ΔPSI)	2	0		
				Previous Next	
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#### Screen 2

- 1) Design Period is the length of time the design is intended to last before the pavement reaches the end of its serviceable life and requires rehabilitation.
- 2) Reliability Level (R) is 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 determine the corresponding  $Z_R$ .



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#### AASHTO Suggested Reliability Levels For Various Functional Classifications

Reliability Level (*R*): 50% to 95%, depending on Roadway Classification 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 look up Z<sub>R</sub>, the standard normal deviate which is the standard normal table value corresponding to a desired probability of exceedance level. Suggested levels of reliability for various Functional Classifications (1993 AASHTO Guide, Table 2.2, page II-9):

Eurotional Classification	Recommended Lo	evel of Reliability
	Urban	Rural
Interstate and Other Freeways	85–99.9	80–99.9
Principal Arterials	80–99	75–95
Collectors	80–95	75–95
Local	50–80	50–80
	Functional Classification       —         Interstate and Other Freeways	Recommended LoFunctional ClassificationUrbanUrbanUrbanInterstate and Other Freeways85–99.9Principal Arterials80–99Collectors80–95Local50–80



<b>Pave</b> Xpress				Logout -	Screen 3
Home Getting Started - My Projects A	bout 🗸				
Main Street				Save Print	AADT
Project Information Location, Roadway Classification and Pavement Type	Traffic Data Method of Determining ESALs:	Using AADT Annual ESALs	Design ESALs	0	
2 Design Parameters Specific Design Variables	Completion Year Traffic (vehicles)	0 Calculate f	from AADT		
3 Traffic Data Traffic and Loading Data	Load Equivalency Factor	0 Calculate I			
4 Pavement Structure Pavement Layer(s) Information	Design Period	20 Years			
5 Pavement Sub-Structure Base, Sub-Base and Subgrade	ESAL Growth Rate Total Design ESALs (W <sub>18</sub> )	0 % i			
Calculated Design					
				Previous Next	





### **PaveXpress**



#### Screen 3

1) Method of Determining ESALS by Average Annual Daily Traffic

#### 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.



### **PaveXpress**

PaveXpress	pout -			Screen	3
Main Street         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         Image: Calculated Design	Traffic Data Method of Determining ESALs: Completion Year ESALs Design Period ESAL Growth Rate Total Design ESALs (W <sub>18</sub> )	Using AADT Annual E 0 i 20 Years 0 % i 0 î	SALs Design ESALs	Annuaresa	_3
PaveXpre	SS		١	www.PaveXpressDesign.com	19



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Nome Getting Started • My Projects About •     Main Street <b>Project Information Design Parameters Source Design Parameters Source Design Parameters Source Design Parameters Total Design ESALs</b> (Wu) <b>O a  Previous</b> with <b>Previous</b> with <b></b>	PaveXpress				Logout 🔹	Screen 3
Project Information   Location, Rodukry Classification and   Pasement Type   Traffic Data Pavement Structure Eavement Layer(s) Information Ease, Sub-Base and Subgrade Ease, Sub-Base and Subgrade Pavement Sub-Structure Location Rodukry Classification and part and	Home Getting Started - My Projects Main Street	About -			Save	Design ESALs
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         image: Calculated Design         Previous Two	1 Project Information Location, Roadway Classification and Pavement Type	Traffic Data Method of Determining ESALs:	Using AADT A	Annual ESALs Design ESAL	0	
3       Traffic Data Traffic and Loading Data         4       Pavement Structure Pavement Layer(s) Information         5       Parement Sub-Structure Base, Sub-Base and Subgrade         Image: Calculated Design       Image: Calculated Design         Image: Previous       Next         Image: Previous       Next	2 Design Parameters Specific Design Variables	Total Design ESALs ( $W_{18}$ )	0	0		
Pavement Structure         Pavement Sub-Structure         Base, Sub-Base and Subgrade         Calculated Design         Previous         Next	3 Traffic Data Traffic and Loading Data					
5 Pavement Sub-Structure Base, Sub-Base and Subgrade   Calculated Design     Previous     Next     O Pavia Systems Inc. 2014     Disclaimer   Privacy Policy   Terms of Service	4 Pavement Structure Pavement Layer(s) Information					
Calculated Design         Previous         Next         @ Pavia Systems Inc. 2014         Disclaimer       Privacy Policy         Terms of Service	5 Pavement Sub-Structure Base, Sub-Base and Subgrade					
Previous     Next       © Pavia Systems Inc. 2014     Disclaimer     Privacy Policy     Terms of Service	Calculated Design					
© Pavia Systems Inc. 2014 Disclaimer Privacy Policy Terms of Service					Previous Next	
	© Pavia Systems Inc. 2014	Disc	laimer	Privacy Policy	Terms of Service	



### Where Can I Find Traffic Data?

- Many DOTs post their traffic count data online
- Contact the Traffic Division of the DOT
- Contact the Traffic Division of the city, if available
- If no official traffic count is available, conduct a short-term count
- Interview local people and businesses

The bottom line is, try to document in some way why you selected the number for input into the design software.







#### 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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#### 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.





	Logo	Screen 5
Main Street           Project Information           Location, Roadway Classification and Pavement Type           Design Parameters           Specific Design Variables           Traffic Data Traffic and Loading Data	Save          Base Layers         Layer       Drainage         Type       Coef.         Click on the Add Layer button below to add a Base Layer.         Add Layer         Subserved	Print
<ul> <li>Pavement Structure Pavement Layer(s) Information</li> <li>Pavement Sub-Structure Base, Sub-Base and Subgrade</li> <li>Calculated Design</li> </ul>	Resilient Modulus (M <sub>R</sub> )     15000     psi     Calculate MR     i       Subgrade	
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#### Adding an Aggregate Base Layer

The designer can add an aggregate base layer (or any other type of base or subbase layer) here.

The default layer coefficients are reasonable, but can be overridden.

The default resilient modulus  $(M_R)$  values came from SHRP2 research, and can also be overridden.

The AASHTO recommended minimum thickness values are:

4" < 500 ESALs 6" > 500 ESALs

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her per specification, or ba material) in inches. The fo ed from AASHTO:	x sed on practical ollowing minimum
Aggregate Base -	0
0.14	0
1	0
28000 psi	0
4 in	0
Yes No	0
	Cancel Add Layer
PavoVaroceDo	sign com
	her per specification, or ba e material) in inches. The for ed from AASHTO: Aggregate Base - 0.14 1 28000 psi 4 in Yes No

#### Subgrade Considerations

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

- California Bearing Ratio (CBR)
- Resistance Value (R)
- Resilient Modulus (M<sub>R</sub>)



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## Subgrade Considerations

The Asphalt Institute publication IS-91 gives the following test values for various subgrade qualities:

Relative Quality	<i>R</i> -Value	California Bearing Ratio	Resilient Modulus (psi)
Good to Excellent	43	17	25,000
Medium	20	8	12,000
Poor	6	3	4,500

Note that different design guides will show different ranges for the various subgrade qualities — use engineering judgment when evaluating subgrade design inputs.







#### Screen 6

### 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.





## 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

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Projects > HMA Overlay >		🗅 Print
SCENARIO INFORMATION PAVEMENT LAYERS CONDITIO	N SURVEY LAYER COEFFICIENTS DESIGN PARAMETERS	TRAFFIC & LOADING DESIGN GUIDANCE
cenario Information 💌		
Scenario Information	Pavement Design	
Scenario Name	Estimated Completion Year 🧧	9
HMA Overlay	2019	
A second s		
Scenario Description	Roadway Classification 🤪	
Cenario Description One Course HMA Overlay	Roadway Classification 💡	
Scenario Description One Course HMA Overlay	Roadway Classification 😔	
Scenario Description One Course HMA Overlay State ? Michigan	Roadway Classification 😪 Local - Project Type 🚱 AC Overlay on Asphalt -	
Scenario Description One Course HMA Overlay State 🚱 Michigan	Roadway Classification ? Local ~ Project Type ? AC Overlay on Asphalt ~ Structural Evaluation Method	8
Scenario Description One Course HMA Overlay State 🚱 Michigan	Roadway Classification 😔 Local - Project Type 📀 AC Overlay on Asphalt - Structural Evaluation Method Condition Survey -	0



### AC Overlay Design

Ay Projects > HMA Overlay	> Layer Type ♀ Layer Type ↓ Asphalt - Dense Graded Asphalt - Open Graded		1 Print	
Pavement Layers Existing Pavement Layers 🥥	Aggregate Base Cement treated base Bituminous treated base Asphalt stabilized base Subbase Other	ayer		
Layer Type	Thickness	Action?		
Add Layer				
Subgrade	New AC	New AC Overlay		
Subgrade Soil Type	Layer Coel	Layer Coeff. (a) 😧		
	0.44			



#### AC Overlay Design

y Projects > HMA Overlay >	🗅 Print		
SCENARIO INFORMATION PAVENENT LAYERS CONDITION SURVEY I	AYER COEFFICIENTS DESIGN PARAMETERS	TRAFFIC & LOADING DESIGN GUIDANCE	
Pavement Layers			
Existing Pavement Layers 💡			
Layer Type	Thickness	Action?	
Asphalt - Dense Graded	4 in.	6 0	
Aggregate Base	6 in.	6.0	
Subhase	12 in.	60	
Subust			
Add Layer			
Add Layer Subgrade	New AC Overlay		
Add Layer Subgrade Subgrade	New AC Overlay		
Add Layer Subgrade Subgrade Soil Type 😧	New AC Overlay Layer Coeff. (a) 😜 0.42		
Add Layer Subgrade Soll Type	New AC Overlay Layer Coeff. (a) 😜 0.42 Minimum Thickness 📀		


#### AC Overlay Design

Home Getting Started - My Projects About -		
y Projects > HMA Overlay >	Print	
SCENARIO INFORMATION PAVEMENT LAYERS CONDITION SURVEY LAYER CO	FFICIENTS DESIGN PARAMETERS TRAFFIC & LOADING DESIGN GUIDANCE	
Condition Survey		
Alligator Cracking 👴	Transverse Cracking 💡	
Low         Medium         High           0 ⋅ %         0 ⋅ %         0 ⋅ %	Low         Medium         High           Image: Second secon	
Cores	Distressed Pavement	
Were cores taken on the roadway? 😔	Mill/Remove Distressed Asphalt? 😧	
Were cores of cracks taken? 😧	Depth to remove () 1 inches	



y Projects > HMA Overlay >	
	<b>_</b> Print
SCENARIO INFORMATION PAVEMENT LAYERS CONDITION SURVEY LAYER COEFFICIENTS DESIGN PARAMETERS TRAFFIC & LOADING	DESIGN GUIDANCE
ayer Coefficients	
Layers	
Layer Type Existing Thickness AASHTO Recommendation Layer Coef. (a) Drainag	e Coef. (m) SN
Asphalt - Dense Graded         4"         0.35 to 0.40         0.35	1.4
Aggregate Base 6" 0.00 to 0.1	0.6
Subbase         12"         0.00 to 0.1         0.08         1	1.0
Subbase         12"         0.00 to 0.1         0.08         1	1.0
Subbase         12"         0.00 to 0.1         0.08         1	1.0

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Home Getting Started + My Projects About +		
ly Projects > HMA Overlay >		🗅 Print
	• • • • • • • • • • • • • • • • • • •	••
Design Parameters		
Design Parameters Design Parameters	Serviceability	
Design Parameters Design Period	Serviceability Initial Serviceability Index (p <sub>i</sub> )	
Design Parameters Design Period	Serviceability Initial Serviceability Index (p.) ? 4.5 Terminal Serviceability Index (n.) ?	
Design Parameters         Design Period         15         Reliability Level (R) $75 \cdot Z_R = -0.674$	A.5 Terminal Serviceability Index (p,) ? 2	
Design Parameters         Design Period ?         15       ye         Reliability Level (R) ?         75 •       Z <sub>R</sub> = -0.674         Combined Standard Error (S <sub>0</sub> ) ?	Serviceability Initial Serviceability Index (p <sub>i</sub> )  4.5 Terminal Serviceability Index (p <sub>i</sub> )  2 Change in Serviceability (ΔPSI)	



#### AC Overlay Design

Home Getting Started -		
My Projects > HMA O	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	🗅 Print
	Average Annual Daily Traffic (AADT) 😧	
SCENARIO INFORMATION PAVEMENT	0 vehicles & LOADING	DESIGN GUIDANCE
Traffic & Loading	Lanes Measured (AADT ¥ 1.0) 😧 One-Way 🗸 1.0	
Traffic Data	Directional Lanes (AADT ¥ 1.0) 😧	
Method of Determining ESALs	Year of Traffic Count	
Using AADT Annual ESALs De	2019	
Completion Year Traffic (vehicles)	Historical Traffic Growth Rate 😧	96
	1 %	
Load Equivalency Factor 😡	Completion Year Traffic 😣	
	0	90
Completion Year ESALs 🚱		
0		
	Cancel Set Completion Year Traffic	

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Home Getting Started - My Projects About -		
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SCENARIO INFORMATION PAVEMENT LAYERS CONDITION SURVEY	LAYER COEFFICIENTS DESIGN PARAMETERS TRAFFIC & LOADIN	G DESIGN GUIDANCE
Traffic Data	Traffic Growth	
Traffic Data Method of Determining ESALs 😧	Traffic Growth Design Period	
Traffic Data         Method of Determining ESALs         Using AADT         Annual ESALs         Design ESALs	Traffic Growth Design Period 15 Years	
Traffic Data Method of Determining ESALs  Using AADT Annual ESALs Design ESALs Completion Year Traffic (vehicles) ?	Traffic Growth Design Period 15 Years Future Traffic Growth Rate ?	
Traffic Data         Method of Determining ESALs         Using AADT       Annual ESALs         Design ESALs         Completion Year Traffic (vehicles)         547500	Traffic Growth Design Period 15 Years Future Traffic Growth Rate ? 1	96
Traffic Data         Method of Determining ESALs         Using AADT       Annual ESALs         Design ESALs         Completion Year Traffic (vehicles)         547500       Calculate from         Load Equivalency Factor       Calculate from	Traffic Growth Design Period 15 Years Future Traffic Growth Rate ? 1 ESAL Growth Rate ?	96
Traffic Data         Method of Determining ESALs         Using AADT         Annual ESALs         Design ESALs         Completion Year Traffic (vehicles)         547500         Calculate from         Load Equivalency Factor         0.0751         Calculate from	Traffic Growth Design Period 15 Years Future Traffic Growth Rate ? 1 ESAL Growth Rate ? 1 ESAL Growth Rate ? 1 Total Design 56AL 5 (W =) ?	96



#### AC Overlay Design

Specific S > HMA Overlap >     Image: Specific S > HMA Ove	Home Getting Started • My Projects About •			
Source       Second base       Second base       Second base         Suppose       Suppose       Suppose       Suppose         Suppos	y Projects > HMA Overlay >		C Print	
Scoped Design         Asphalt - Densis Graded         Appropriate Base         Subbase         Subbase         Subbase         Subbase         Subbase         Subprade    Person Rome Removed 2 inches from the surface of the pavement prior to the center of this design.	SCEMARIO INFORMATION PAVEMENT LAYERS CONDITION SURVEY LAYER CO	EFFICIENTS DESIGN PARAMETERS TRAFFIC & LOADI	G DESIGN GUIDANCE	
Scoped Design         Asphalt - Densis Graded         Appregate Base         Subbase         Subbase         Subbase         Subparde    Pesign Notes          You have removed 2 inches from the surface of the pavement prior to the overlagin.	Guidance			
Overlag:       Layer Thicknesses (in)         Aggregate Base       Overlay: 0.9         Asphat - Dense Graded:       2         Subbase:       12         See Calculation Details       See Calculation Details         Vou have removed 2 inches from the surface of the pavement prior to the overlag.       Image: Calculation Details         You have removed 2 inches from the surface of the pavement prior to the overlag.       Image: Calculation Details	Scoped Design			
Subbase     Aggregate Base: 6 Subbase: 12 See Calculation Details       Design Notes     Resources       You have removed 2 inches from the surface of the pavement prior to the overlay in this design.     Resources	Opening Asphalt - Dense Graded Aggregate Base	Layer Thicknesses (in) Overlay: 0.9 Asphalt - Dense Graded: 2		
Subgrade       Design Notes       You have removed 2 inches from the surface of the pavement prior to the overlay in this design.	Subbase	Aggregate Base: 6 Subbase: 12 See Calculation Details		
Design Notes     Resources       You have removed 2 inches from the surface of the pavement prior to the overlay in this design.     Image: Control of the pavement prior to the overlay in this design.	Subgrade			
You have removed 2 inches from the surface of the pavement prior to the overlay in this design.	Design Notes	Resources		
	You have removed 2 inches from the surface of the pavement prior to the overlay in this design.			

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#### Screen 6

**Overlay:** Once the existing pavement information is input, PaveXpress uses the AASHTO equations to calculate the existing or effective structural number (*SN*) of the pavement. From the design and loading information, the required *SN* to support the loadings over the design life is calculated. The difference in the required *SN* and the existing *SN* is converted to an overlay thickness. If this thickness is less than minimum thickness input on Screen 2 or the required *SN* is less than the existing *SN*, then PaveXpress will report the minimum overlay thickness value.



## **Rigid Pavements**

PaveXpress can also be used to design rigid pavements in accordance with the AASHTO Design Guide 1998 Supplement for Rigid Pavements.



The steps are similar, but geared toward the values and inputs important to concrete pavements.





### **PaveXpress**

#### 1998 AASHTO Design Guide Equation — Basic Overview

$$\log_{10}(W_{18}) = Z_R \times S_0 + 7.35 \times \log_{10}(D+1) - 0.06 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.5 - 1.5}\right)}{1 + \frac{1.624 \times 10^7}{(D+1)^{8.46}}} + (4.22 - 0.32p_t) \times \log_{10}\left[\frac{(S_c')(C_d)(D^{0.75} - 1.132)}{215.63(J)\left(D^{0.75} - \frac{18.42}{(E_c/k)^{0.25}}\right)}\right]$$

Where:

 $W_{18}$  = the predicted number of 18-kip equivalent single axle load (ESAL) applications

- $Z_R$  = standard normal deviate
- $S_0$  = combined standard error of the traffic prediction and performance prediction
- D = slab depth (inches)
- $\Delta PSI =$  difference between the initial design serviceability index ( $p_i$ ) and the design terminal serviceability index ( $p_t$ )
- $S'_c$  = modulus of rupture of PCC (flexural strength)
- $C_d$  = drainage coefficient
- J = load transfer coefficient
- $E_c$  = elastic modulus of PCC
- k = modulus of subgrade reaction



### Layered Elastic Analysis





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# **Recent Additions to PaveXpress**



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#### **Source Materials and References**

PaveXpress's LCCA model is based on research embedded in...







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#### **Multiple Use Cases for LCCA**



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lifo	Cyc	Cost	Ana	lycic
	CyC	CUSL	Alla	LY SIS

SCENARIO INFORMATION ANALYSIS OPTIONS TRAFFIC DATA TRA	PFIC HOURLY VALUE OF USER TIME ALTERNATIVES RESULTS
Scenario Information	
Scenario Name	Analyzed By
Cascade LCCA	James F
Scenario Description New Bus Lane + resurface 3 lanes Alt 1: SMA 30 Alt 2: AC 30 days	Project Extent Begin: End: 1 1.3
Analysis Direction	Comments V Agency costs only; user costs excluded
State 🤣	

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Life Cycle	Lost /	Ana	lysis
y Projects > Cascade St. > Cascade LCC	A		C) Print
SCENARIO INFORMATION ANALYSIS OPTIONS TRAFFIC DATA	TRAFFIC HOURLY VALUE OF USER TO	NE ALTEMATIVE	S RESULTS
Analysis Period <table-cell> 50 ye Beginning Year of Analysis Period 📀 2012</table-cell>	Include User Costs in A User Cost Computation M Calculated + Calculated Specified	unalysis 🤣 ethod 🤣	
Previous Next			Save
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PaveXpress

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Alternative 1 🖌 🗗			×
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Alternative 2 💉 🗗			×
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Previous Next Save	Analysis Period <table-cell> 50 years Beginning Year of Analysis Period 😔 2012</table-cell>	⊘ Include User Cost User Cost Computa Calculated	its in Analysis	
	Previous			Save

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### Porous Pavement Design





#### **PaveXpress**

#### Porous Pavement Design



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# PaveXpress 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

**PaveXpress** 

#### PaveInstruct





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- New Pav't Design
- Overlay Design
- M-E Design and Evaluation

- Intro to M-E Design w/ PerRoad
- PerRoad Design
- Porous Pav't Design
- Initial Costing and LCCA Functions

**PaveXpress** 

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	Content	
	<ul> <li>Session 6 - PerRoad Design (Full Video)</li> <li>6.1 Perpetual Pavement Design Concepts</li> <li>6.2 PerRoad Design Example</li> <li>6.3 Comparing PavExpress and PerRoad</li> <li>6.4 Summary</li> </ul>	
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**PaveXpress** 

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**PaveXpress** 



#### **Perpetual Pavements – PerRoad**

#### PerRoad 4.4

PerRoad uses the mechanisticempirical design philosophy. The program couples layered elastic analysis with a statistical analysis procedure (Monte Carlo simulation) to estimate stresses and strains within a



pavement. Version 4.4 provides design results as percentile responses and as conventional designs with transfer functions. In order to predict strains that would prove detrimental for fatigue cracking or structural rutting, PerRoad requires the following inputs:

#### PerRoadXpress 1.0

PerRoadXpress is an easy-to-use, all-on-one-screen program for designing Perpetual Pavements for low- and medium-volume roads and parking lots. The designer chooses a type of asphalt cement. PerRoadXpress then allows the designer either to use defaults for traffic and soil, or to input the actual values if they are known. Granular base thicknesses from 0 to 10 inches are included. The software quickly provides the user with a recommendation for the total thickness of asphalt pavement needed for a particular situation. PerRoadXpress was developed

http://www.asphaltroads.org/why-asphalt/engineering/perpetual-pavement/

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- Residential and Commercial Paving
- Compaction
- Milling & Profiling
- Pavement Repair
- Work Zone Safety

- Paver Operations
- Positioning Technology for Asphalt Pavements
- Leadership, Communication & Planning in Paver Operations

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# **Other Resources**



## **Other Tools**



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# **Questions**?



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#### Learning Pavement Design with PaveXpress

The PaveInstruct learning module is a web-based pavement design education system with video instruction by leading dindustry experts. PaveInstruct accompanies PaveXpress, a web-based software created to design flexible and rigid pavements using AASHTO 93/98. The education modules within PaveInstruct Correlate with the design modules in PaveXpress and provide technically sound pavement design and instruction.

#### **PAVE**Instruct

Instruction Please click below to enter the PaveInstruct learning module system. Presentations are available in short clips or in full format.

Learning Center

#### PAVEXpress

Design Please click below to enter the PaveXpress design system.

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