



Industrial Parking Lots Asphalt Pavement Designs

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INFRASTRUCTURE



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HEALTH SOLUTIONS



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- M.S. Civil Engineering, University of Illinois at Urbana-Champaign
- Principal Engineer, Group Leader (IL Consulting Services)
 - 21 years of consulting engineering experience
 - Emphasis on alternative delivery projects, pavement evaluation and design, and asset management
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Industrial Parking Lots – Asphalt Pavement Designs

Asphalt Pavement Design Basics

AASHTO '93 Designs

- PaveXpress

Mechanistic Design Checks





Light Duty Lot Example

PAVEXpress with LCCA Module now in Beta!

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Home My Projects

My Projects > Sample Parking Lots > Light Duty - Default

Print

SCENARIO INFORMATION

DESIGN GUIDANCE

Scenario Information

Scenario Information

Scenario Name

Light Duty - Default

Scenario Description

light duty default to show design overlooked

State

Illinois

Pavement Design

Estimated Completion Year

2020

Roadway Classification

Parking Lot - Light Duty

Project Type

New - Asphalt





Light Duty Lot Example – No Design Necessary?

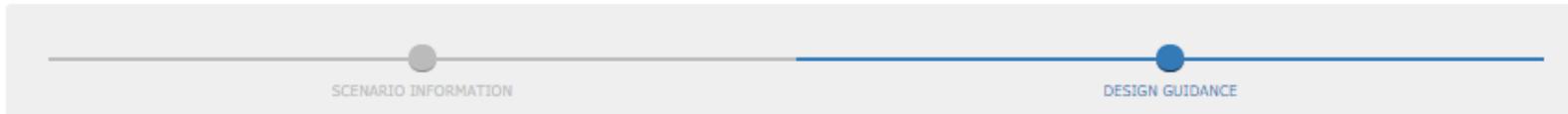
PAVEXpress with LCCA Module now in Beta!

Logout

Home **My Projects**

My Projects > Sample Parking Lots > Light Duty - Default

Print



Guidance

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.

Design Notes

Empty text box for design notes.

Resources



Illinois Asphalt Pavement Association

**IDOT BLR Guidance =
3" HMA
8" Agg Base**



Heavy Duty Parking Lot

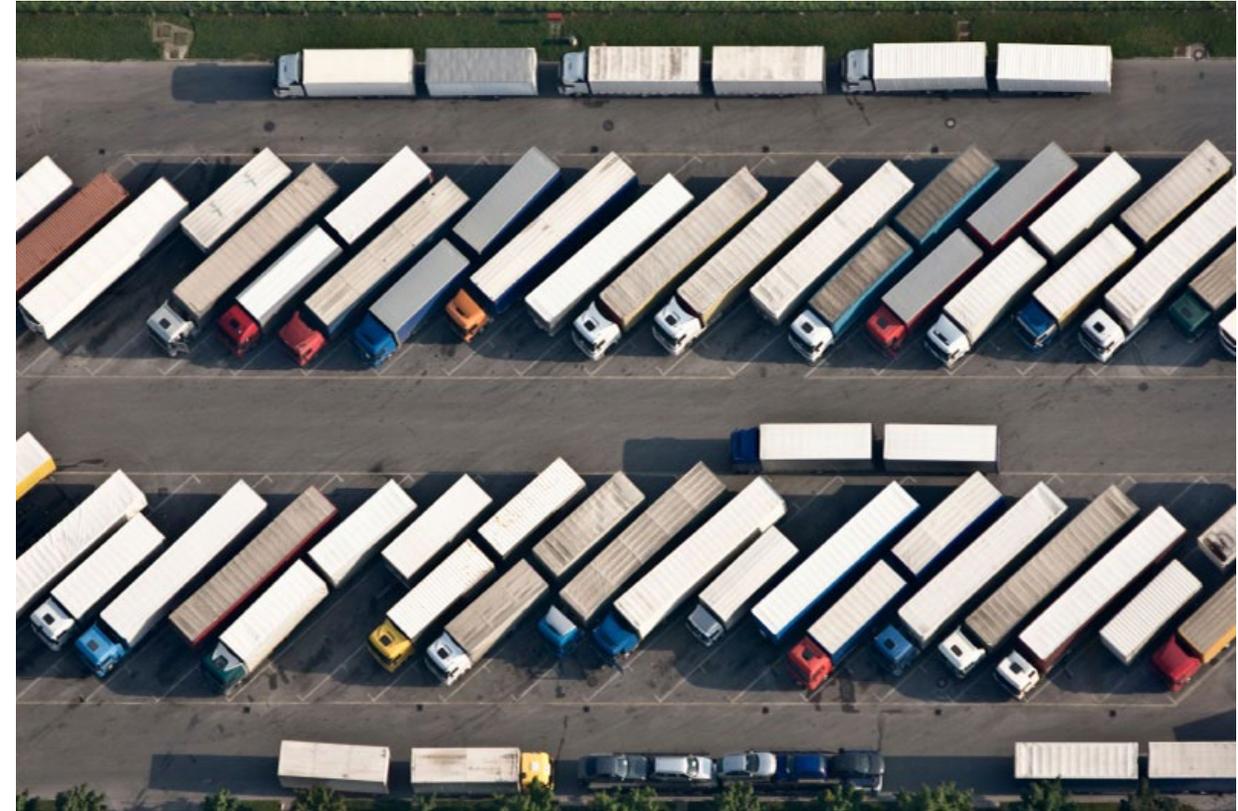
Drive Lanes

Parking Loaded Containers/Trucks

Garbage Trucks

These can be designed with asphalt materials, but...

- Loads matter!
- Subgrade support matters!
- Drainage matters!





AASHTO '93 – Structural Number (SN)

Required structure to support projected loads for design life

Compute a required thickness (SN) – in inches

Assign material layers with appropriate structural layer coefficients

- Greater stiffness = greater structural layer coefficient



AASHTO '93 – Structural Number (SN)

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

Where:	W_{18}	=	predicted number of 80 kN (18,000 lb.) ESALs
	Z_R	=	standard normal deviate
	S_o	=	combined standard error of the traffic prediction and performance prediction
	SN	=	Structural Number (an index that is indicative of the total pavement thickness required)
		=	$a_1D_1 + a_2D_2m_2 + a_3D_3m_3 + \dots$ $a_i = i^{th}$ layer coefficient, $D_i = i^{th}$ layer thickness (inches), $m_i = i^{th}$ layer drainage coefficient
	ΔPSI	=	difference between the initial design serviceability index, p_i , and the design terminal serviceability index, p_t
	M_R	=	subgrade resilient modulus (in psi)

Source: *PavementInteractive.com*



AASHTO '93 – PaveXpress

Default Truck Factor = 1.0

- Assumes blend of loaded/unloaded trucks

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)
 ?	0 %	✕ 0.0001
 ?	0 %	✕ 0.4
 ?	100 %	✕ 1
 ?	0 %	✕ 1.75
 ?	0 %	✕ 0
Total	100 %	
Load Equivalency Factor	1	

Cancel

Set LEF and Close



AASHTO '93

Calculate a Truck Factor!



80,000lb truck		
16000 single steer axle		0.7
32000 drive tandem axle		1
32000 trailer tandem axle		1
	ESAL/truck	2.7

Table 1. Some Typical Load Equivalency Factors

Axle Type (lbs)	Axle Load		Load Equivalency Factor (from AASHTO, 1993)	
	(kN)	(lbs)	Flexible	Rigid
Single axle	8.9	2,000	0.0003	0.0002
	44.5	10,000	0.118	0.082
	62.3	14,000	0.399	0.341
	80.0	18,000	1.000	1.000
	89.0	20,000	1.4	1.57
	133.4	30,000	7.9	8.28
Tandem axle	8.9	2,000	0.0001	0.0001
	44.5	10,000	0.011	0.013
	62.3	14,000	0.042	0.048
	80.0	18,000	0.109	0.133
	89.0	20,000	0.162	0.206
	133.4	30,000	0.703	1.14
	151.2	34,000	1.11	1.92
	177.9	40,000	2.06	3.74
222.4	50,000	5.03	9.07	

Source: *PavementInteractive.com*



AASHTO '93 - PaveXpress

Update Truck Factor

80,000-lb truck = 2.7

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)
?	<input type="text" value="0"/> %	<input type="text" value="0.0001"/>
?	<input type="text" value="0"/> %	<input type="text" value="0.4"/>
?	<input type="text" value="100"/> %	<input type="text" value="2.7"/>
?	<input type="text" value="0"/> %	<input type="text" value="1.75"/>
?	<input type="text" value="0"/> %	<input type="text" value="0"/>
Total	<input type="text" value="100"/> %	
Load Equivalency Factor	<input type="text" value="2.7000"/>	



AASHTO '93 - PaveXpress

This example is for 50 trucks per day

PAVEExpress with LCCA Module now in Beta!

Logout

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My Projects > Sample Parking Lots > Heavy Duty - 50 trucks/day

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Scenario Information

Scenario Information

Scenario Name

Heavy Duty - 50 trucks/day

Scenario Description

heavy duty example

State ?

Illinois

Pavement Design

Estimated Completion Year ?

2020

Roadway Classification ?

Parking Lot - Heavy Duty

Project Type ?

New - Asphalt



AASHTO '93 - PaveXpress

Different CBR Correlation

Calculate Subgrade ×

Modulus

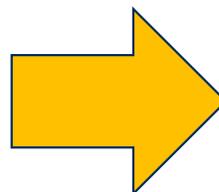
Calculation Method ?

CBR R-Value

CBR ?

Subgrade Modulus (M_R)

psi



Calculate Subgrade ×

Modulus

CBR Calculation ×

$MR = 2555 \times CBR^{0.64}$

Calculation Method ?

CBR R-Value

CBR ?

Subgrade Modulus (M_R)

psi



AASHTO '93 - PaveXpress

Aggregate Base Properties

Typically IDOT CA-6 (crushed stone base)

We recommend a minimum of 6" of stone base

- More stiffness = better support for pavement
- More stiffness = better construction platform
- Helps with site drainage and separation

Edit Structural ×

Layer

Layer Type ?
Aggregate Base ▾

Layer Coefficient ?
0.14

Drainage Coefficient ?
1

Resilient Modulus (M_R) ?
30000 psi

Thickness ?
8 in

Is Thickness Fixed? ?
 Yes No



AASHTO '93 - PaveXpress

HMA Material Properties

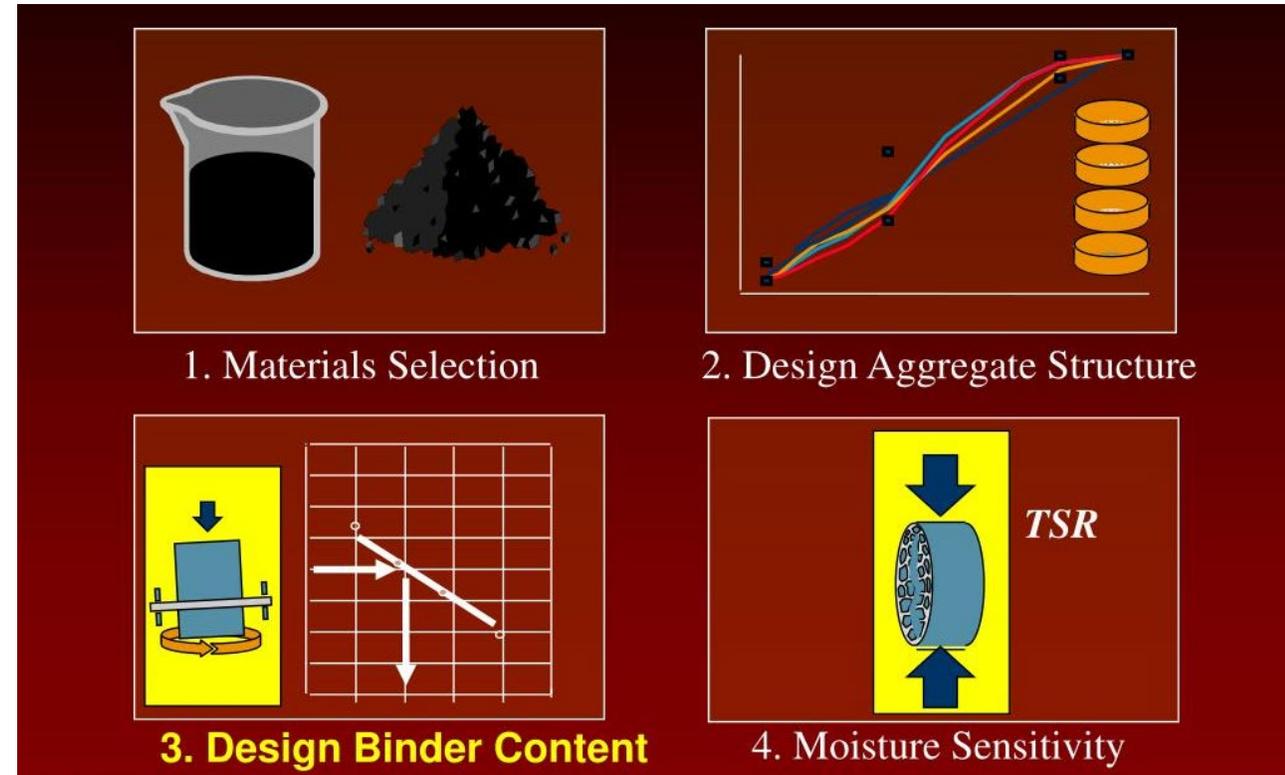
Typical State-mixtures

- With Quality Control Testing

Surface $a_i = 0.40-0.44$

Intermediate $a_i = 0.36-0.40$

Base $a_i = 0.36-0.40$





AASHTO '93 – PaveXpress (50 trucks per day)

Results!

2.0” HMA Surface

4.0” HMA Base

13.5” CA-6

This is A LOT more than 3” over 8”

Guidance

Layer	Thickness (in)
Surface (AC)	2.00
Binder/Intermediate (AC)	2.00
Base (AC)	2.00
Aggregate Base	13.50
Total	19.50

Required minimum design SN: 3.85

Total SN: 3.88



AASHTO '93 Results

AASHTO 93	20-yr MESAL	Required SN	HMA Surface (0.40/in)		HMA Binder (0.33/in)		Agg Base (0.13/in)		Calc SN
50 trucks/day	0.98	3.85	2	0.8	4.0	1.32	13.5	1.76	3.88
100 trucks/day	1.98	4.10	2	0.8	5.0	1.65	13.0	1.69	4.14
150 trucks/day	2.96	4.40	2	0.8	5.5	1.82	14.0	1.82	4.44
200 trucks/day	3.94	4.60	2	0.8	5.5	1.82	15.5	2.02	4.63
240 trucks/day	4.92	4.75	2	0.8	6.0	1.98	15.5	2.02	4.80

Significant structure needed to carry truck traffic



Typical Structures

Depends on truck traffic loading

Bank = Deposit trucks, garbage trucks

Fast food lots = Supply trucks, garbage trucks

Schools = BUSES, garbage trucks, supply trucks for cafeterias



Quiz: why does summer school matter?



Typical Structures – Spec Design?

Unknown future tenant

Design parking lots and drive lanes expecting some trucks

- 50 trucks/day is a good minimum, more is better

Communicate design assumptions to tenant when they lease space!

- Responsibility, accountability, defined expectations



AASHTO '93 - PaveXpress

Structural Analysis

Also called Mechanistic Design Check

Layered Elastic Analysis (LEA)

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CROSS SECTION LOADS RESPONSE LOCATIONS (X, Y) RESPONSE LOCATIONS (Z) TRANSFER FUNCTIONS RESULTS

Cross Section

Cross section layers ?

Layer Type	Poissons Ratio	Modulus (psi)	Thickness (in)	Action?
Asphalt - Dense Graded	0.35	500000	4.5	✎ ⊗
Aggregate Base	0.4	30000	10	✎ ⊗

[Add Layer](#)

Subgrade Poissons Ratio (μ) ?

Subgrade Modulus (M_R) ?
 psi

Cross section diagram



AASHTO '93 - PaveXpress

Analysis locations

Desired criteria

- Horizontal strains (fatigue)
- Vertical strains (rutting)

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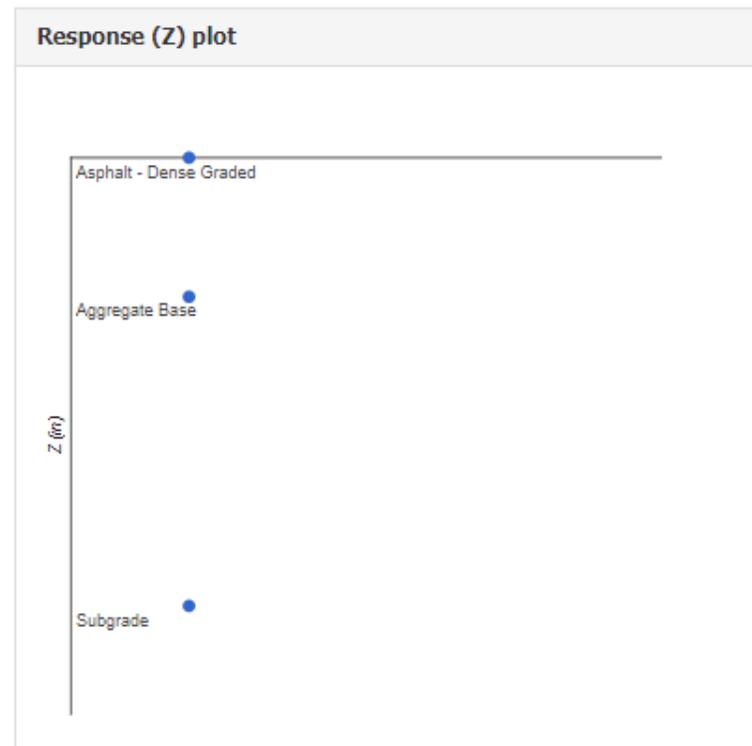


Response Locations (Z)

Response (Z) data

Layer	Depth (in)	Strain	Action?
Asphalt - Dense Graded	0	↕↔↪	☑ ⊗
Asphalt - Dense Graded	4.5	↕↔↪	☑ ⊗
Subgrade	14.5	↕↔	☑ ⊗

Add Response Reset





Up Next – Mike Ward, Rabine Paving

Thanks!