Industrial Parking Lots Asphalt Pavement Designs

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NATIONAL SECURITY

INFRASTRUCTURE

ENERGY & ENVIRONMENT

HEALTH SOLUTIONS

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  - 21 years of consulting engineering experience
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Industrial Parking Lots – Asphalt Pavement Designs

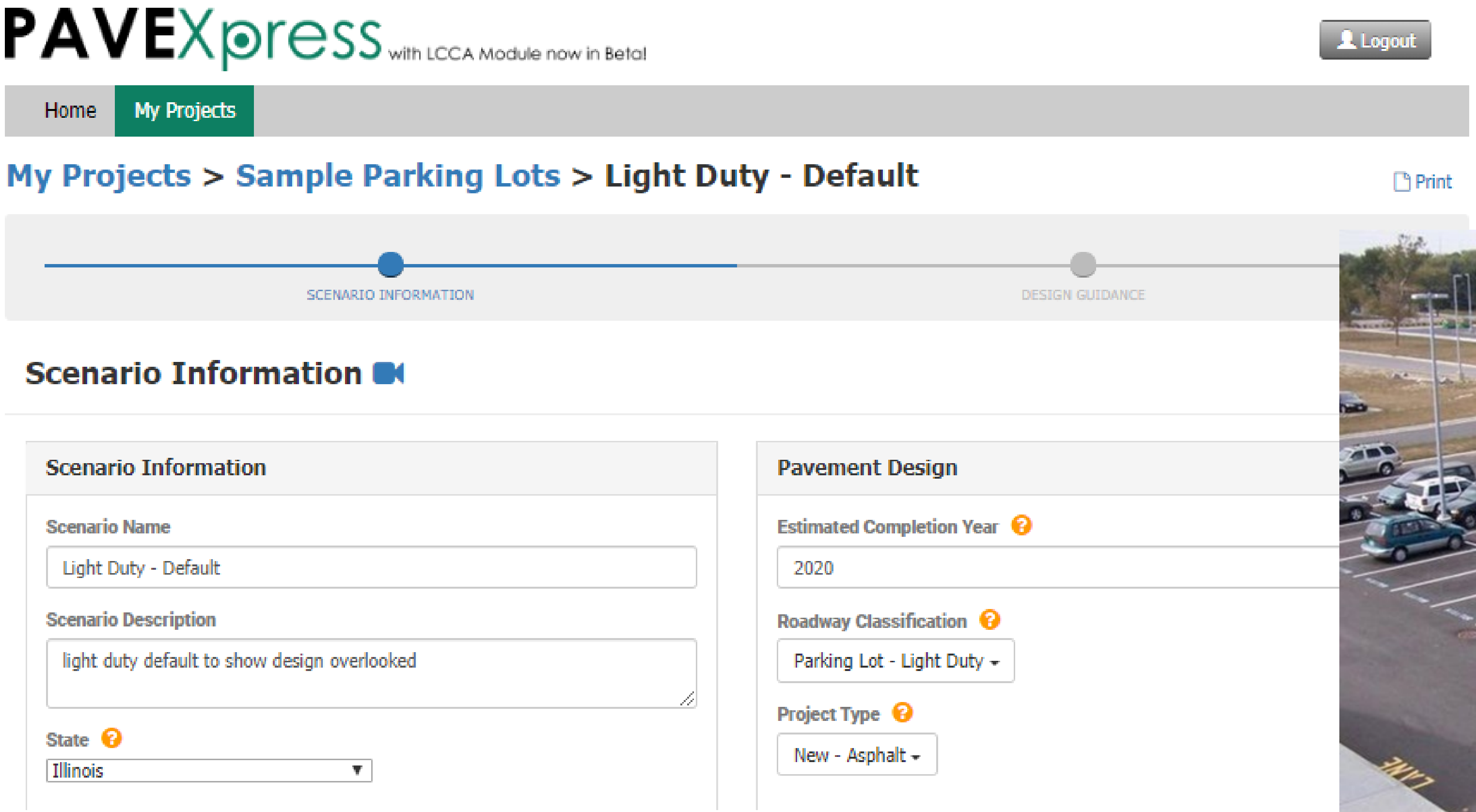
Asphalt Pavement Design Basics

AASHTO ‘93 Designs

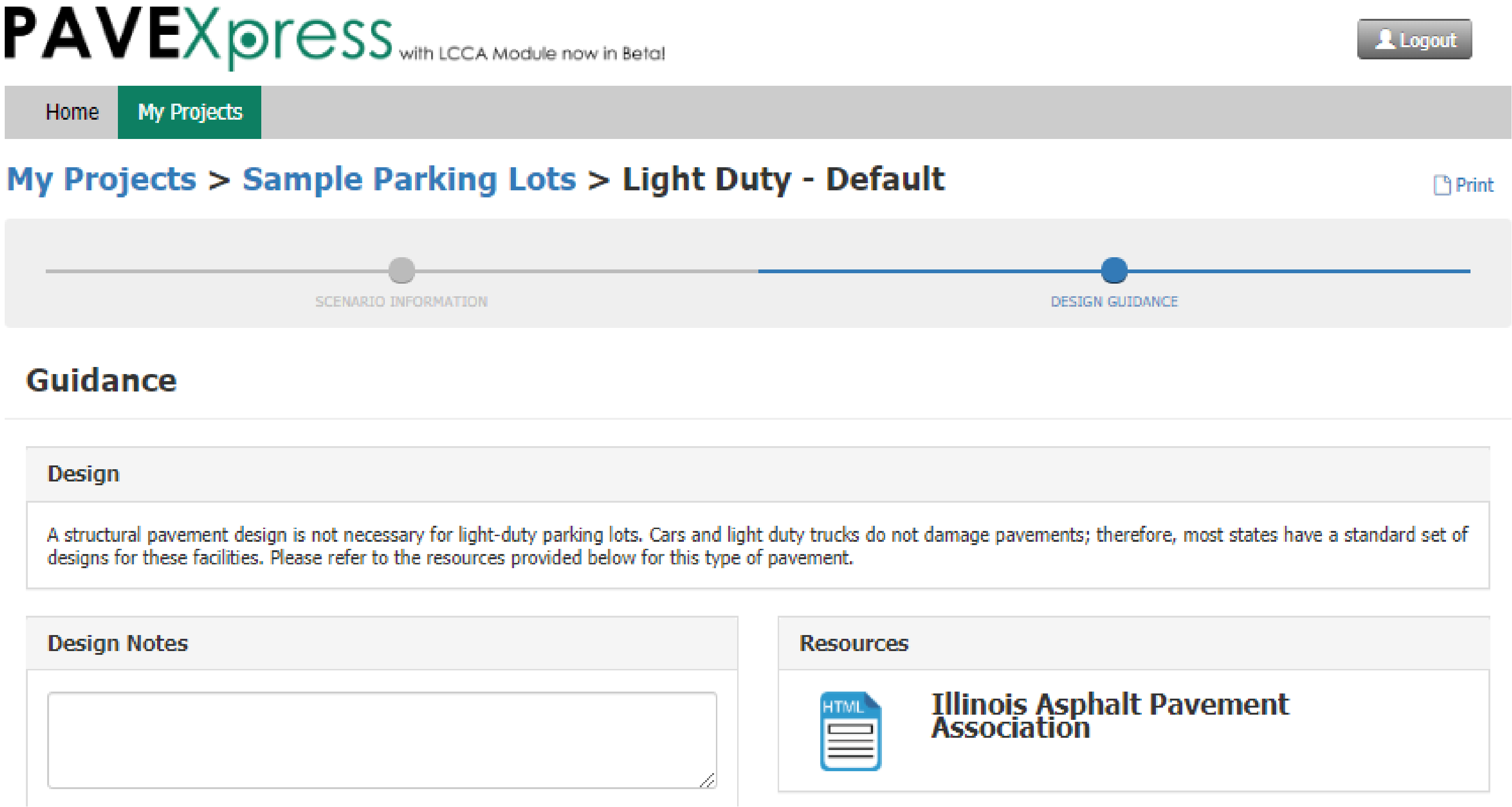
- PaveXpress

Mechanistic Design Checks

Light Duty Lot Example



Light Duty Lot Example – No Design Necessary?



IDOT BLR Guidance =

3" HMA

8" Agg Base

Heavy Duty Parking Lot

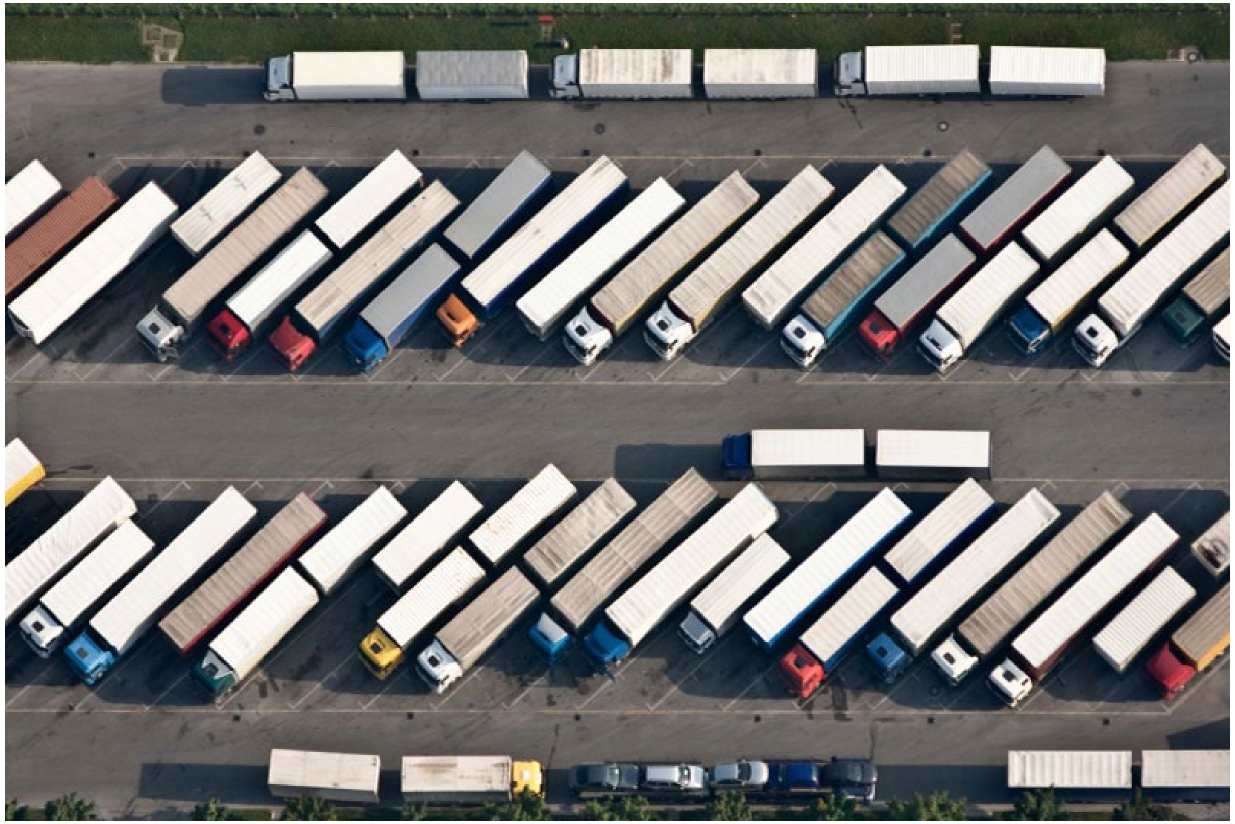
Drive Lanes

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)
		=	$a_1D_1 + a_2D_2m_2 + a_3D_3m_3 + \ldots a_i$ = ithlayer coefficient, D_i = i^{th} layer thickness (inches), m_i = i^{th} layer drainage coefficient
	ΔPSI	=	difference between the initial design serviceability index, pi, and the design terminal serviceability index, pt
	M_R	=	subgrade resilient modulus (in psi)

Source: PavementInteractive.com

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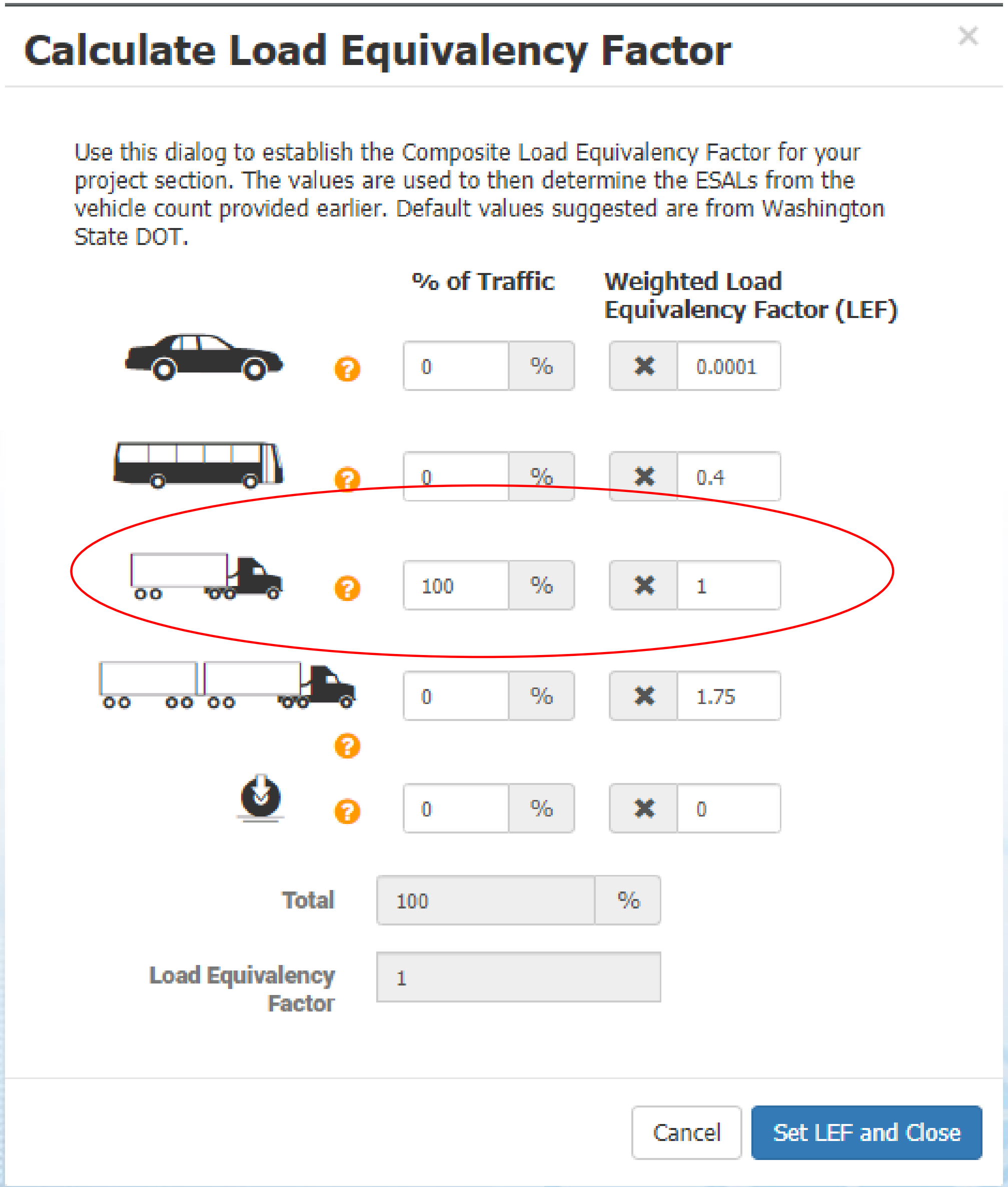
www.ara.com

AASHTO '93 – PaveXpress

Default Truck Factor = 1.0

- Assumes blend of loaded/unloaded trucks



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

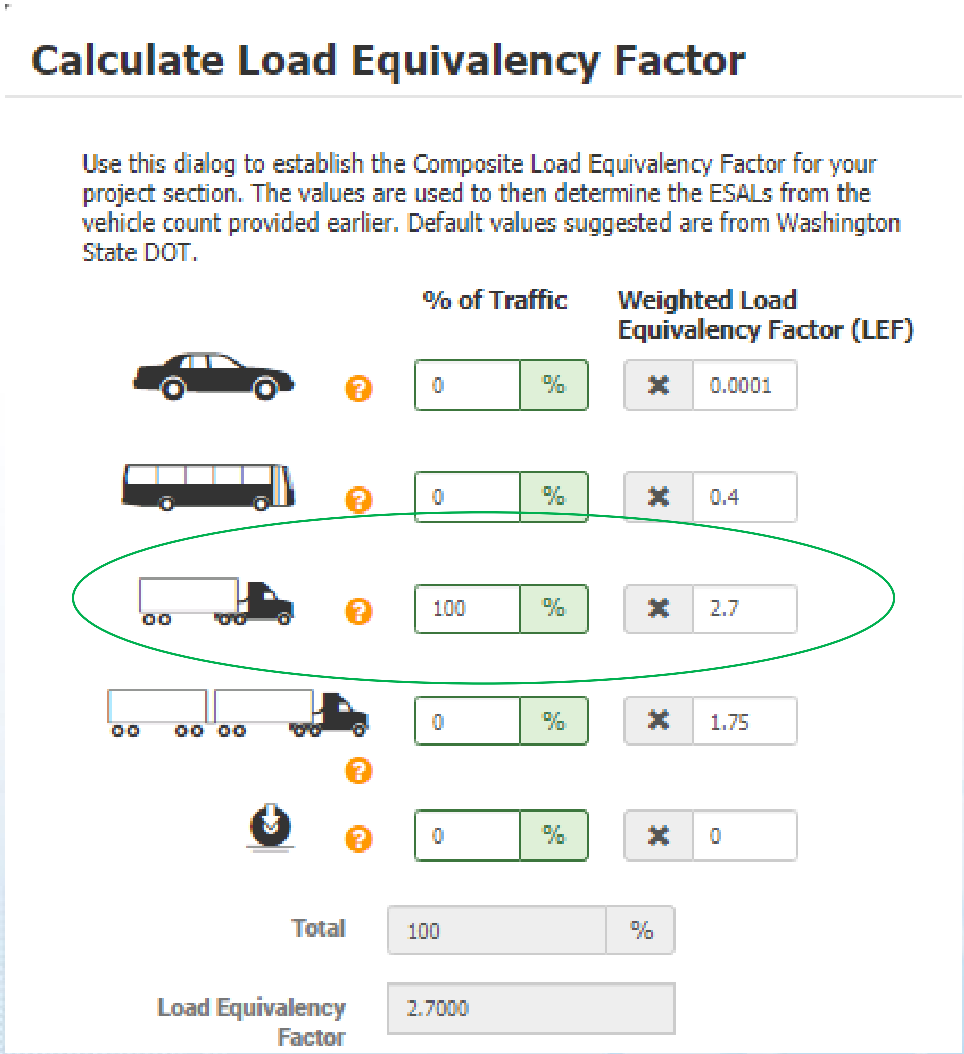
Axle Type (lbs)	Axle Load		Load Equivalency Factor (from AASHTO, 1993)	
	(kN)	(lbs)	Flexible	Rigid
Single axle	8.9 44.5 62.3 80.0 89.0 133.4	2,000 10,000 14,000 18,000 20,000 30,000	0.0003 0.118 0.399 1.000 1.4 7.9	0.0002 0.082 0.341 1.000 1.57 8.28
Tandem axle	8.9 44.5 62.3 80.0 89.0 133.4 151.2 177.9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

Source: PavementInteractive.com

AASHTO ’93 - PaveXpress

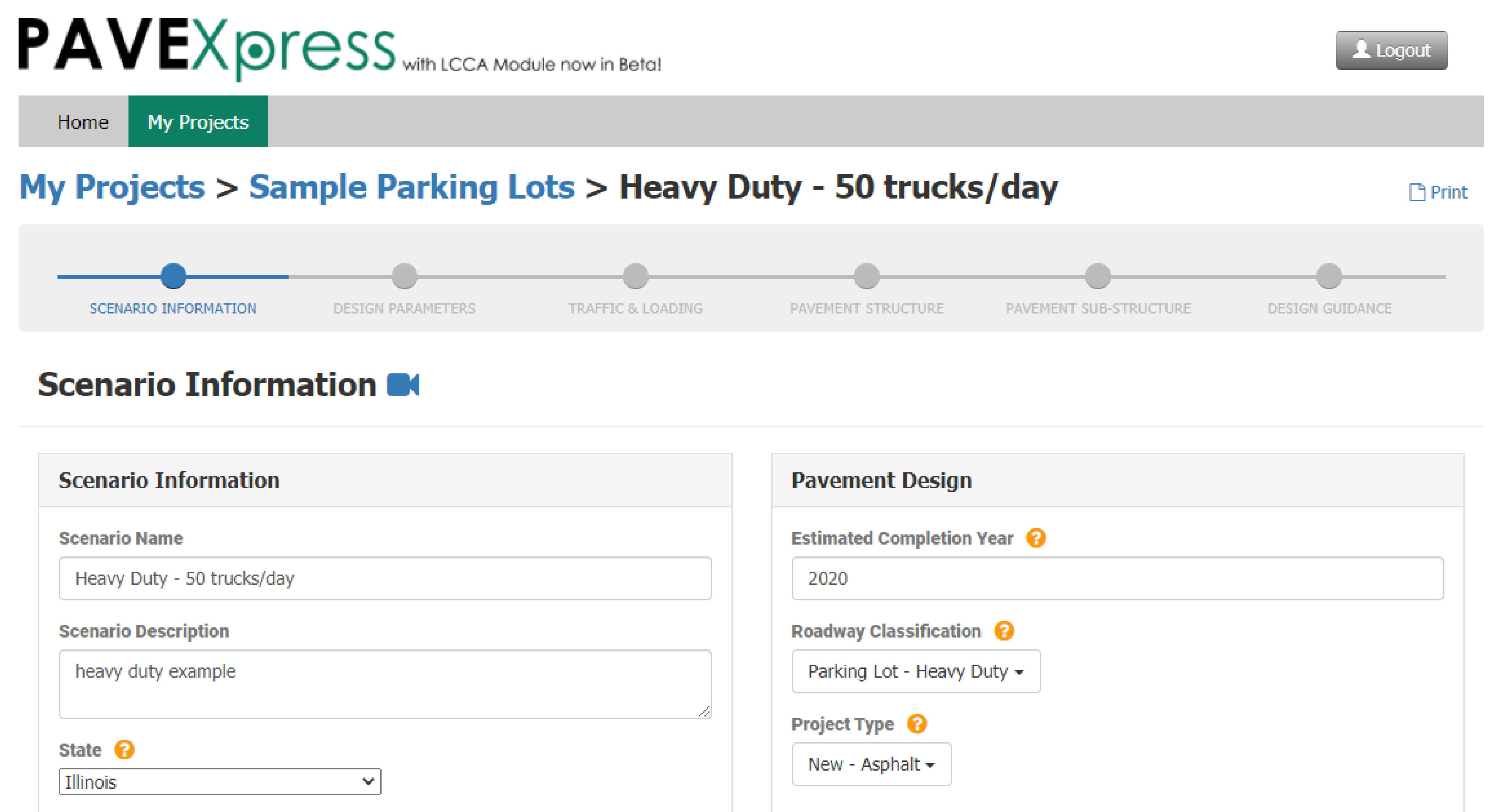
Update Truck Factor

80,000-lb truck = 2.7



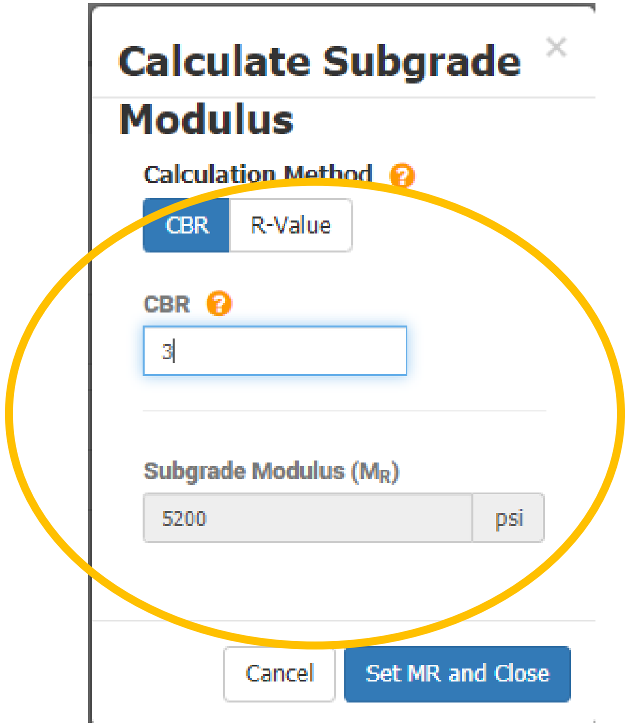
AASHTO ’93 - PaveXpress

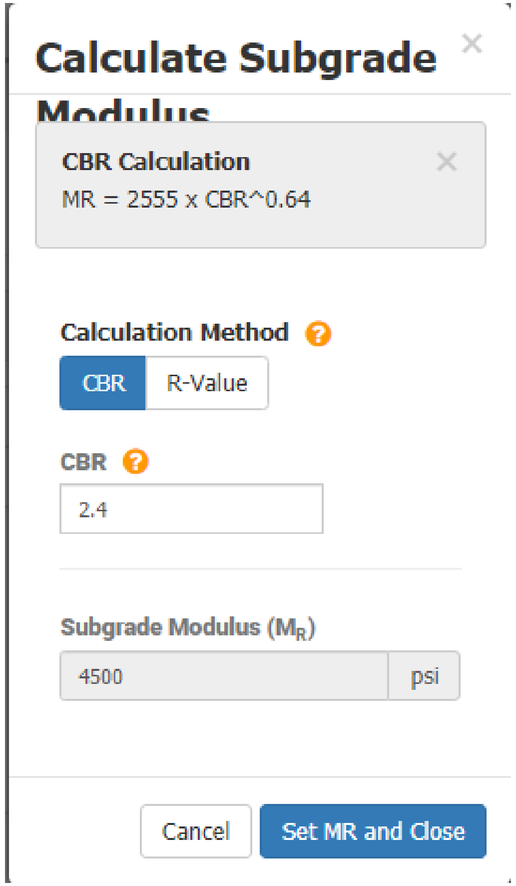
This example is for 50 trucks per day



AASHTO ’93 - PaveXpress

Different CBR Correlation





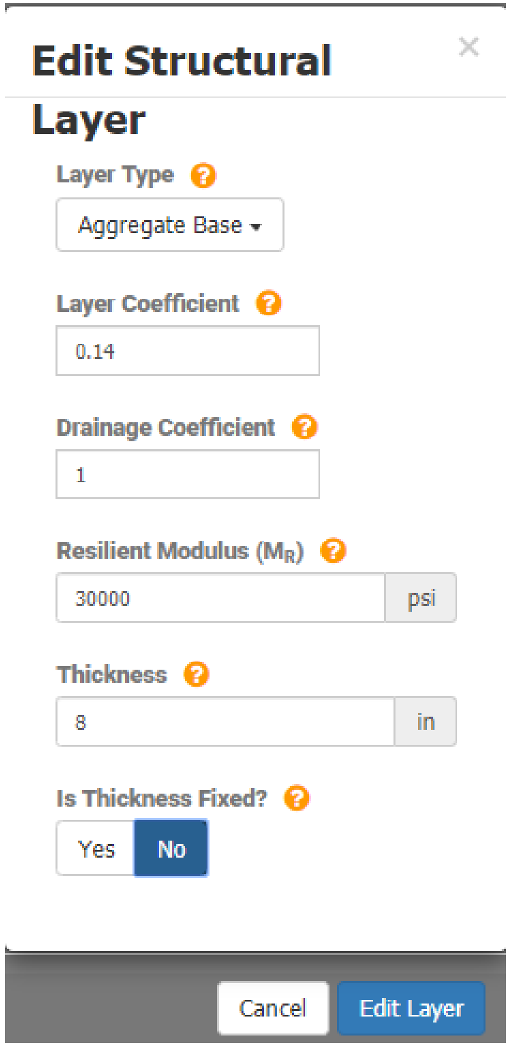
AASHTO '93 - PaveXpress

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



AASHTO '93 - PaveXpress

HMA Material Properties

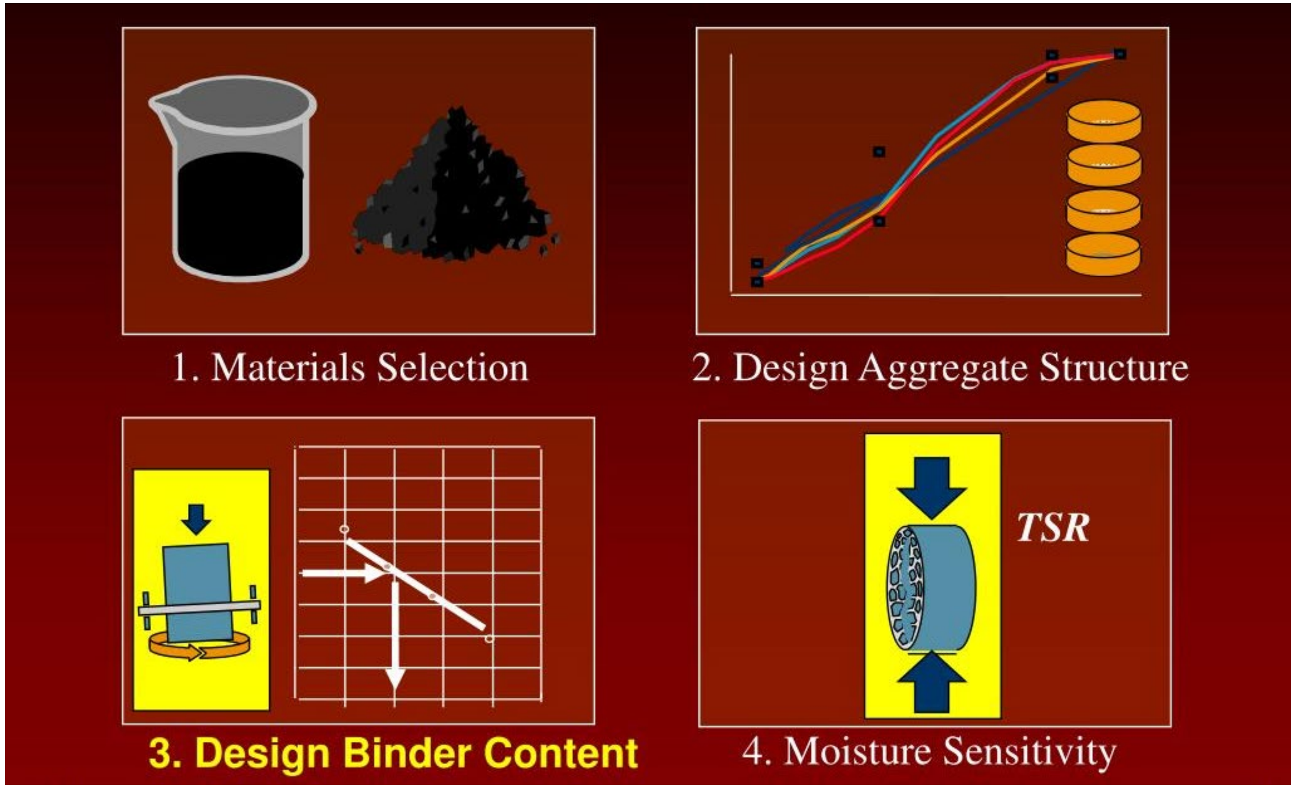
Typical State-mixtures

- 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)

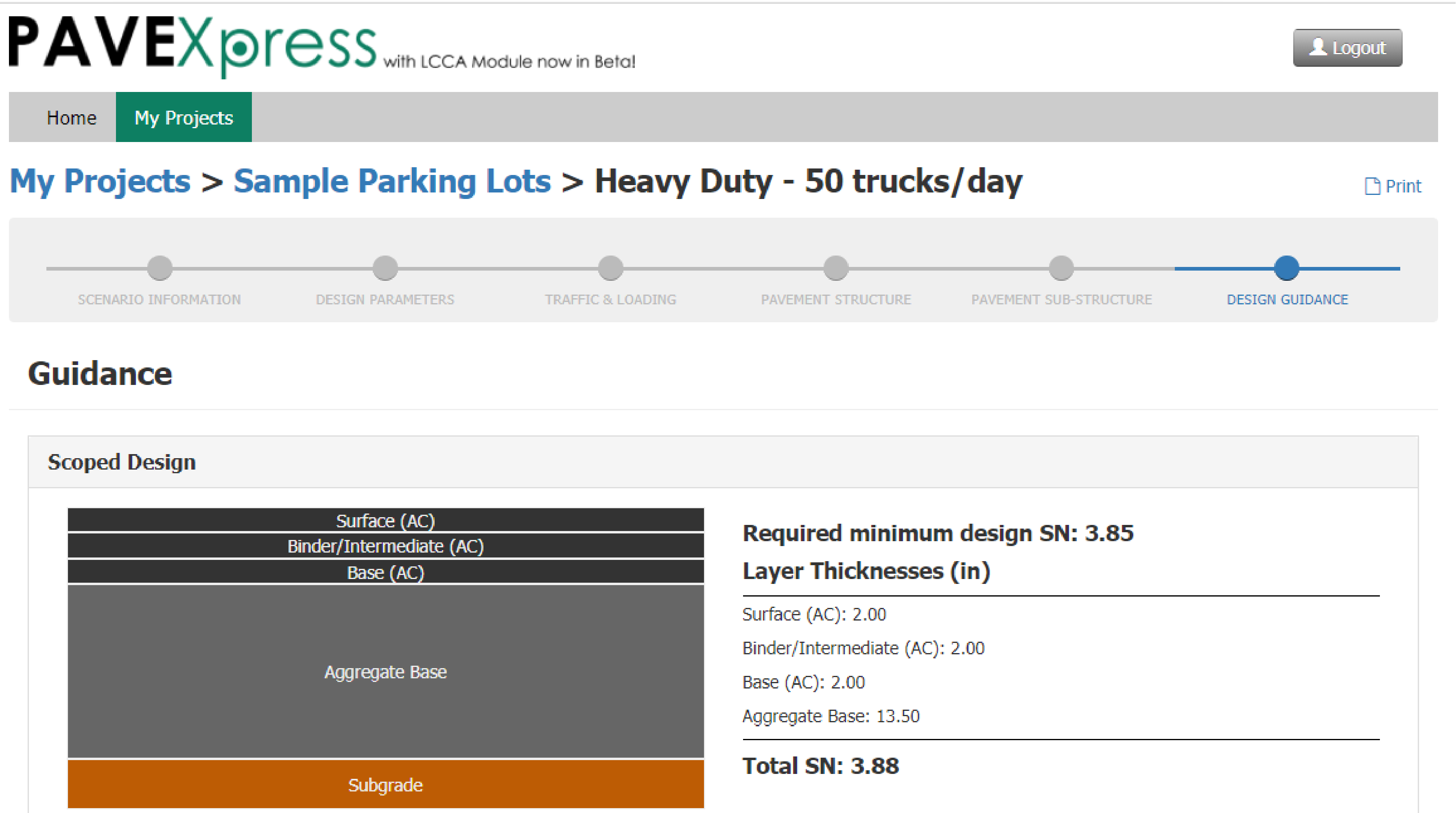
Results!

2.0" HMA Surface

4.0" HMA Base

13.5" CA-6

This is A LOT more than 3" over 8"



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!

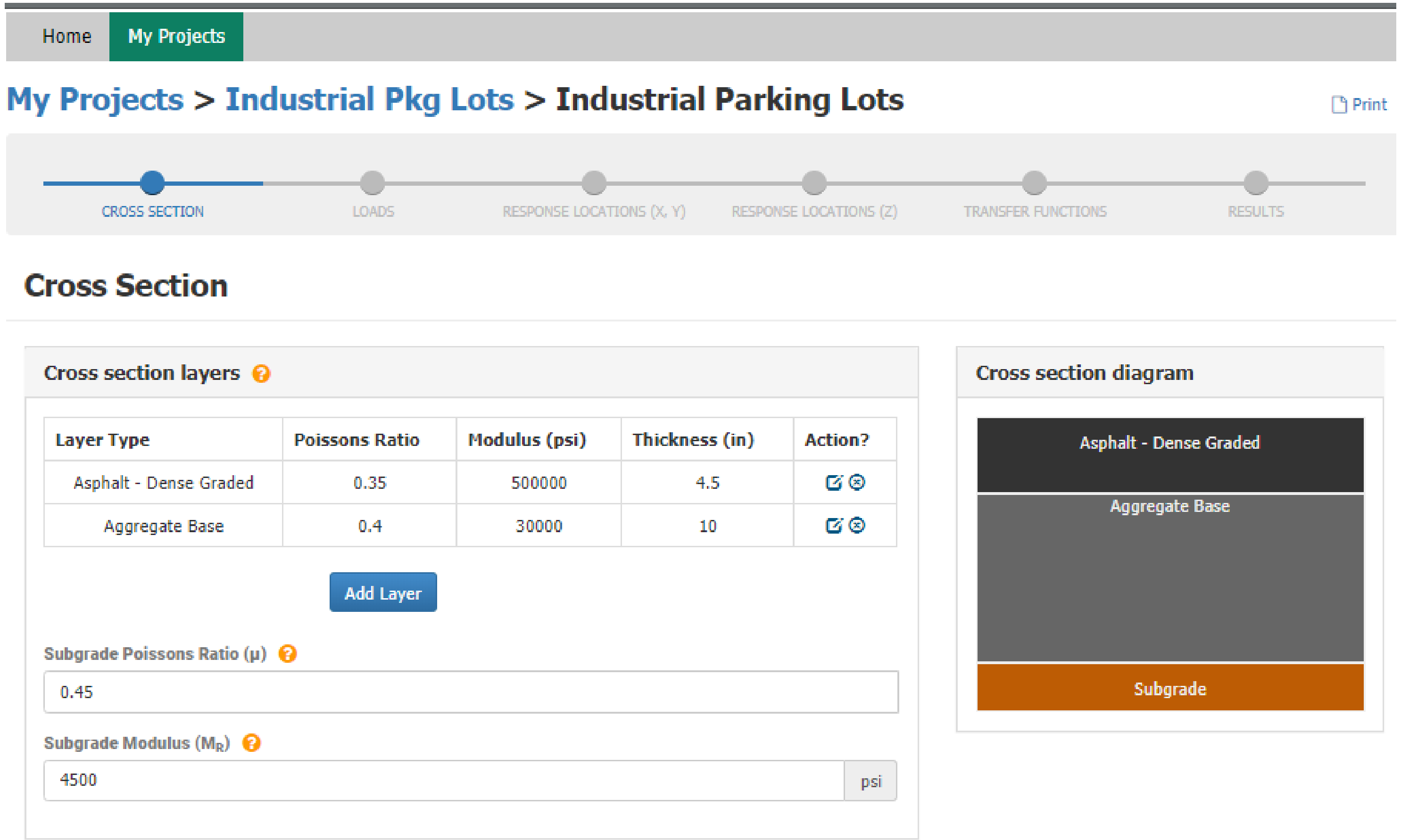
- Responsibility, accountability, defined expectations

AASHTO '93 - PaveXpress

Structural Analysis

Also called Mechanistic Design Check

Layered Elastic Analysis (LEA)



AASHTO ’93 - PaveXpress

Analysis locations

Desired criteria

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

My Projects > Industrial Pkg Lots > Industrial Parking Lots Print

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

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

Response (Z) plot

Up Next – Mike Ward, Rabine Paving

Thanks!