Introduction: Mike Harrell

- B.S. Civil Engineering, University of Illinois at Urbana-Champaign
- 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
  - Licensed PE in IL, IN, and CO

Contact Info:
mharrell@ara.com
217.239.9730
Industrial Parking Lots – Asphalt Pavement Designs

Asphalt Pavement Design Basics

AASHTO ‘93 Designs
• PaveXpress

Mechanistic Design Checks
Light Duty Lot Example

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?

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)

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

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) |
| = | \( a_1D^1 + a_2D^2m^2 + a_3D^3m^3 + \ldots + a_i = \text{ith layer coefficient, } D_i = \text{ith layer thickness (inches), } m_i = \text{ith layer drainage coefficient} \) |
| \( \Delta PSI \) | = | 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
AASHTO '93

Calculate a Truck Factor!

Table 1. Some Typical Load Equivalency Factors

<table>
<thead>
<tr>
<th>Axle Type</th>
<th>Axle Load</th>
<th>Load Equivalency Factor (from AASHTO, 1993)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(kN)</td>
<td>Flexible</td>
</tr>
<tr>
<td>Single axle</td>
<td>(lbs)</td>
<td></td>
</tr>
<tr>
<td>8.9</td>
<td>2,000</td>
<td>0.0003</td>
</tr>
<tr>
<td>44.5</td>
<td>10,000</td>
<td>0.118</td>
</tr>
<tr>
<td>62.3</td>
<td>14,000</td>
<td>0.399</td>
</tr>
<tr>
<td>80.0</td>
<td>18,000</td>
<td>1.000</td>
</tr>
<tr>
<td>89.0</td>
<td>20,000</td>
<td>1.4</td>
</tr>
<tr>
<td>133.4</td>
<td>30,000</td>
<td>7.9</td>
</tr>
<tr>
<td>Tandem axle</td>
<td>(lbs)</td>
<td></td>
</tr>
<tr>
<td>8.9</td>
<td>2,000</td>
<td>0.0001</td>
</tr>
<tr>
<td>44.5</td>
<td>10,000</td>
<td>0.011</td>
</tr>
<tr>
<td>62.3</td>
<td>14,000</td>
<td>0.042</td>
</tr>
<tr>
<td>80.0</td>
<td>18,000</td>
<td>0.109</td>
</tr>
<tr>
<td>89.0</td>
<td>20,000</td>
<td>0.162</td>
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<tr>
<td>133.4</td>
<td>30,000</td>
<td>0.703</td>
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<tr>
<td>151.2</td>
<td>34,000</td>
<td>1.11</td>
</tr>
<tr>
<td>177.9</td>
<td>40,000</td>
<td>2.06</td>
</tr>
<tr>
<td>222.4</td>
<td>50,000</td>
<td>5.03</td>
</tr>
</tbody>
</table>

Source: PavementInteractive.com
AASHTO ‘93 - PaveXpress

Update Truck Factor

80,000-lb truck = 2.7
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

<table>
<thead>
<tr>
<th>AASHTO 93</th>
<th>20-yr MESAL</th>
<th>Required SN</th>
<th>HMA Surface (0.40/in)</th>
<th>HMA Binder (0.33/in)</th>
<th>Agg Base (0.13/in)</th>
<th>Calc SN</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 trucks/day</td>
<td>0.98</td>
<td>3.85</td>
<td>2</td>
<td>0.8</td>
<td>4.0</td>
<td>1.32</td>
</tr>
<tr>
<td>100 trucks/day</td>
<td>1.98</td>
<td>4.10</td>
<td>2</td>
<td>0.8</td>
<td>5.0</td>
<td>1.65</td>
</tr>
<tr>
<td>150 trucks/day</td>
<td>2.96</td>
<td>4.40</td>
<td>2</td>
<td>0.8</td>
<td>5.5</td>
<td>1.82</td>
</tr>
<tr>
<td>200 trucks/day</td>
<td>3.94</td>
<td>4.60</td>
<td>2</td>
<td>0.8</td>
<td>5.5</td>
<td>1.82</td>
</tr>
<tr>
<td>240 trucks/day</td>
<td>4.92</td>
<td>4.75</td>
<td>2</td>
<td>0.8</td>
<td>6.0</td>
<td>1.98</td>
</tr>
</tbody>
</table>

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)
Up Next – Mike Ward, Rabine Paving

Thanks!