Constructability: Designing Buildable Pavements

2018 Pavement Conference
Charleston, WV
October 23-26, 2018
Pavement Condition

Pavement Performance

Pavement Condition Index

Time or Traffic

0

100
Pavement Condition

- Reactive Maintenance
- Preventive Maintenance

Graph showing pavement condition over time or traffic.
Superpave

Strategic Highway Research Program (SHRP)

- Superpave, which stands for
  - Superior
  - Performing Asphalt
  - Pavements
- Performance-based specification
- Asphalt grades are called
  - Performance Graded (PG) Binders
PG Binders

PG 64-22

147.2 F  -7.6 F

“Performance Grade”

Average 7-day max pavement temperature

Minimum pavement temperature
PG Binder Grades Topeka, KS

PG 64-34 (98% minimum reliability)

PG 58-28 (50% minimum reliability)

PG grades - six degree increments
The Rule of 92

PG 70-28
PG 70-28 Probably Modified

PG 64-22
PG 64-22 Probably Unmodified

TEMPERATURE °C
Example

• Mainline pavement
  PG 64-22

• Toll booth
  PG 70-22

• Weigh Stations
  PG 76-22

70 mph

Slow

Stopping
# Asphalt Mixtures

## Standard Superpave Sieves

<table>
<thead>
<tr>
<th>Diameter (in)</th>
<th>Equivalent (mm)</th>
<th>Equivalent (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#8</td>
<td>2.36</td>
<td>2.36</td>
</tr>
<tr>
<td>#16</td>
<td>1.18</td>
<td>1.18</td>
</tr>
<tr>
<td>#30</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>#50</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>#100</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>#200</td>
<td>0.075</td>
<td>0.075</td>
</tr>
</tbody>
</table>
Defined by aggregate size

**Nominal Maximum Aggregate Size**
- One size larger than first sieve to retain more than 10%

**Maximum Aggregate Size**
- One size larger than nominal maximum size
## Superpave mix designations

<table>
<thead>
<tr>
<th>Superpave Designation</th>
<th>Max Size, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5 mm</td>
<td>50.0</td>
</tr>
<tr>
<td>25.0 mm</td>
<td>37.5</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>25.0</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>19.0</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>12.5</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>9.5</td>
</tr>
</tbody>
</table>
Asphalt Mixtures

Mat thickness
- 3x max aggregate
- 4x larger stone mixes

Fracture aggregate

Open Texture

Water intrusion
“AASHO Road Test”
“AASHO Road Test”
FIGURE 14 Loop 1 of the AASHO Road Test in September 2005: 
(a) PCC pavement and (b) HMA pavement.
Flexible Nomograph

As traffic increases, thickness continues to increase.
Mechanistic Design

Mechanistic -

“Concerning the Relationships Between Applied Forces and Material Responses.”

Basic Premise -

Low Deflections = Long Life
» Thin Asphalt Pavement = Higher Strain

» Higher Strain = Shorter Fatigue Life
- Lower Tensile Strain
  - Increasing Pavement Thickness
  - Increasing Layer Stiffness

- Strain Below Fatigue Limit = Indefinite Life

Diagram:
- Compressive Strain
- Thick - Stiff HMA
- Tensile Strain
- Fatigue Life
- Indefinite Fatigue Life: 65-70 με
Bottom-up Fatigue and Rutting

Repeated Bending Leads to Fatigue Cracking

Repeated Deformation Leads to Rutting

HMA

Unstabilized Base

Subgrade
Mechanistic Performance Criteria

- ESAL Applied
- Limit Bending to < 65-70με (Monismith, Von Quintus, Nunn, Thompson)
- Limit Vertical Compression to < 200με (Monismith, Nunn)

Layers:
- Thick HMA (> 8”)
- Base (as required)
- Subgrade
Longitudinal crack in M1 TRL
New Jersey I-287
Surface Cracking
Perpetual Pavement

(3) SMA, OGFC or SUPERPAVE
(2) High Modulus Rut Resistant Asphalt
(1) Flexible Fatigue Resistant Asphalt
Ohio DOT
Long Life Pavement Study

• Recommended 16.25 inches full depth asphalt for all interstate pavements
• When the study was published several rehabilitations were under construction at 17 in.
Cost and Benefits

- **Conventional pavement with periodic rehabilitation**
- **Perpetual pavement with surface renewal**

**Cost in $ (net present value)**

- **Initial Construction Cost**
- **Life Cycle Cost to Agency**
- **Work Zone User Costs**
Perpetual Pavement Design Software

- PerRoad 4.4
- PerRoad Express

- Dr Dave Timm at Auburn University
  - Developed and maintains the software
- Couples layered elastic analysis with a statistical analysis procedure (Monte Carlo simulation)
- To estimate stresses and strains within a pavement
- Predicts whether your design will perform as a Perpetual Pavement

http://www.asphaltroads.org/PerRoad/
Thanks,

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