Asphalt Institute
to Univ. of KY
A.S.C.E. Student Chapter
10/5/16

Mark Buncher, Ph.D., P.E.
Director of Engineering
US-based association of international asphalt binder producers, manufacturers, and affiliated businesses.

Formed on 1919.
- Oldest asphalt association in world
Current AI Membership

Over 140 Companies

– Represents approx. 94% of asphalt binder sold in U.S.
Asphalt Institute’s Mission

• Promote the quality use of asphalt through
  • Training and Education
  • Research
  • Engineering
  • Technology Transfer
  • Development of New Technologies
  • Resolution Of Issues

• Unified voice of the asphalt industry
AI Education

• AI Catalog (organized by topic)
  • Technical Pubs and software
  • Training
  • Lab Services

• Seminars & Webinars Brochure
  • Topics cover:
    • Binders and Emulsions
    • Mixtures and Mix Design
    • Construction
    • Maintenance and Preservation
    • Airport Pavement Technical Workshop

www.asphaltinstitute.org
Teaching Best Practices
Internship Opportunities

Currently accepting resumes for summer 2017 internship positions in locations across the U.S. Our member companies will interview candidates for their locations.

We are finalizing those locations now. If you would like to submit an application or to learn more, go online at asphaltfoundation.org or tschlich@asphaltfoundation.org

Requirements:
• Must be willing to relocate for the summer
• Attend a 2-day Asphalt 101 intern seminar at our AI HQs in Lexington where all foundation interns come together for networking and info related to the asphalt industry
A little about asphalt binders, asphalt mixtures, and constructing asphalt pavements...
“A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in petroleum processing.” – ASTM D8
Two Types of Asphalt

• Natural asphalt deposits
  • Island of Trinidad
  • Bermudez, Venezuela
  • Rock asphalt

• Petroleum asphalts
  • A product of the petroleum industry
Demand for paved roads exceeded the supply of lake asphalts in late 1800’s
  - Led to use of petroleum asphalts
Asphalt Mixtures

- A combination of aggregates, uniformly mixed and coated with asphalt.
We’ve Come a Long Way!
“Crushed stone, crushed gravel, or crushed slag with or without sand or other inert finely divided mineral aggregate.”

• Typically 93-96% by weight, or 83-89% by volume of an asphalt paving mixture
• Aggregates are the load-bearing components within asphalt paving mixtures
Processed aggregates require processing; i.e., crushing, sizing, and/or washing to remove fines prior to use

- Natural Pit Materials
- Quarried Bedrock
### Typical Flexible Pavement Structure
(thicknesses and # of layers depends on structural design)

<table>
<thead>
<tr>
<th>Layer (from top to bottom)</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 - 3” Hot Mix Asphalt (HMA) Wearing Surface</strong></td>
<td>Dense-graded mix, SMA or Open-graded friction course</td>
</tr>
<tr>
<td><strong>HMA Base Layer(s):</strong> High stiffness, rut-resistant, dense-graded or SMA mix</td>
<td></td>
</tr>
<tr>
<td><strong>Possible dense-graded HMA Intermediate Layer(s)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Typical Aggregate Base Course:</strong> (High-quality crushed stone, clean gravels, etc). Thickness depends on structural design.</td>
<td></td>
</tr>
<tr>
<td><strong>Optional Sub-base Layer:</strong> (Lesser quality and strength base course material, such as sand, dirty gravels, etc)</td>
<td></td>
</tr>
<tr>
<td><strong>Subgrade (Compacted Natural Soil)</strong></td>
<td></td>
</tr>
</tbody>
</table>
Mix Types of Dense-graded HMA Used for Surface, Base and/or Intermediate Layers.

Smaller stone (finer) mixes near surface
Larger stone (coarser) mixes in lower lifts

4.75 mm
9.5 mm
12.5 mm
19.0 mm
25.0 mm
37.5 mm
HMA Wearing Surface

Agency engineers will select mix type based on traffic conditions, environment, experience and economics.

- **Dense-graded HMA**
  - Superpave mix design or Marshall mix design
  - low air voids (5-7%)
    - should be impermeable
  - many mix types
  - placed at varying thicknesses

- **Porous Friction Course (PFC)**
  - a.k.a. Open Graded Friction Course (OGFC), or Permeable FC
  - high air voids (16-22%)
    - allows water to flow through layer and out
  - typically placed 1” thick
PERMEABLE/ OPEN GRADED FRICTION COURSE

Benefits

• Skid Resistance
• Eliminates hydroplaning
• Improve surface drainage
• Also less traffic noise outside of vehicle
• Quieter ride inside vehicle
Asphalt Mixtures
aka Hot Mix Asphalt (HMA)

HMA Overlays used as:

• Mill and Fill
  Existing aged HMA surface removed by a milling machine and then new HMA surface placed

• Structural Overlay
  Structural strength added to existing asphalt pavement system by adding new HMA layer(s) and thickness
Objective: “...to determine the combination of asphalt cement and aggregate that will give long lasting performance...” – Asphalt Institute MS-2
Mix Design Is Balancing Act to Achieve All These Desirable Properties

- **Stability** *(resistance to rutting)*
- **Durability** *(air and water damage)*
- **Flexibility** *(bend without cracking)*
- **Fatigue Resistance** *(repeated loads)*
- **Skid Resistance** *(safety)*
- **Impermeability** *(keep air and water out)*
- **Workability** *(placing & compaction)*
### Materials Selection

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Asphalt Binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Makes up 93 to 96% of the mixture</td>
<td>• Makes up 4 to 7% of the mixture</td>
</tr>
<tr>
<td>• Acts as the skeleton of the pavement mixture</td>
<td>• Acts as the “glue” or “muscle” of the mix</td>
</tr>
<tr>
<td>– Carries the load</td>
<td>– Flexibility</td>
</tr>
<tr>
<td>– Skid resistance</td>
<td>– Durability</td>
</tr>
<tr>
<td>– Stability</td>
<td>– Assists the aggregate</td>
</tr>
<tr>
<td>– Workability</td>
<td></td>
</tr>
</tbody>
</table>
Volumetric Analysis Definition:

- The measurement or calculation of the relative volumes occupied by the aggregate, asphalt binder, and air voids in a laboratory compacted asphalt mixture
“Mixture Volumetrics”

• Air Voids
• Voids in Mineral Aggregate (VMA)
• Voids Filled with Asphalt (VFA)
• Dust-to-Asphalt Ratio
• Film Thickness
V_{\text{binder}} = V_{\text{be}} + V_{\text{ba}} \quad \text{Specific Gravity bridges the gap}
Example JMF

- Contains project name
- Blend percentages at various asphalt contents
- Volumetric properties
- Optimum blend
Asphalt Production

- The aggregates and asphalt are combined in a mixing plant where the ingredient materials are heated, proportioned and mixed to produce the desired paving mixture.
Construction Methods
Balancing the Paving Operation
Paver Unit for Placing HMA

Tractor

Hopper

Tow Point

Screed

Augers
Paving Speed

- Consistency, Consistency, Consistency
  - Run non-stop
  - Constant speed – all day
    - Speed increases – depth decreases
    - Speed decreases – depth increased

Why? Change the speed, and you change the balance of the forces.
Importance of Compaction

• Compaction is the final step in construction of a quality HMA pavement
• Good compaction is critical to obtain expected service life
• It is good practice to:
  – Have a density specification
  – Test for density regularly
  – Make density part of the pay factor
Compacting HMA

- Compaction Goal
  - 5-8% In-place Air Voids

- Requirements for Compaction
  - Adequate Effort
    - Use the right rollers, right number of passes, not too fast
  - High Enough Mix Temperatures
    - Haul length
    - Ambient conditions
  - Mixture Confinement
    - Lift thickness
    - Base support
# Thickness Guidelines

<table>
<thead>
<tr>
<th>Maximum Agg Size</th>
<th>Suggested Min Thickness</th>
<th>Suggested Max Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 inch</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>1 inch</td>
<td>2.5</td>
<td>4</td>
</tr>
<tr>
<td>0.75 inch</td>
<td>1.75</td>
<td>3</td>
</tr>
<tr>
<td>0.5 inch</td>
<td>1.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Roller Operations - Temperature Zones

Breakdown Rolling

Intermediate Rolling

Finish Rolling

Typical Temperature Ranges

300° - 260°F

260° - 220°F

180 - 150°F
Some Key Factors To Achieve Long-lasting Performance

• Compaction Critical
  » Mat: 93-94% average in-place max. density
  » Joints: about 2% less density (additional voids)

• Avoid Segregation

• Avoid Moisture Susceptible Mixes!
  – Can Add Liquid Anti-Strip or Lime

• Proper Material Selection

• Drainage, Drainage, Drainage
There must be a reason that 94% of all paved surfaces are ASPHALT.
Asphalt’s Advantages

- Smooth
- Quiet
- Economical
- Safe
- Fast Construction
- Long Life
- Easily Maintained

- Environmentally Friendly
  - 100% Recyclable
  - Lower Carbon Footprint
- Highly Visible Pavement Markings
- Versatile
- Resistant to De-icing Chemicals
Thank you for your attention

Questions?