Track – Asphalt Specifications & Installation Practices

Monday, December 3, 2012
Doubletree Hotel at Universal Orlando

H Wayne Jones, P.E.
Senior Regional Engineer
Asphalt Institute

Outline

Materials
• Liquid Asphalt
• Aggregates
• Asphalt Mixtures
  – Superpave Mix Design
  – Reclaimed Asphalt & Shingles (RAP & RAS)

Construction
• Specifications
• Laydown

New Technologies

The 3 A’s of Hot Mix Asphalt

Asphalt (binder), Aggregates, and Air

HMA = Asphalt + Aggregates + Air

Differences: Asphalt & Tar

• Asphalt
  – Can be naturally occurring
  – Product crude refining
  – Soluble in petroleum
  – Superior for hotmix

• Tar
  – Product of coke production from coal
  – Resistant to petroleum
  – Not good for hotmix
  – Better for surface sealing
  – Falling out of favor

Trinidad Lake Asphalt
**Coal Tar-Based Products**

- Resistant to fuel spills
- Different expansion rate
  - Shrinkage cracks
  - Fuel attacks thru cracks
- High exposure areas
  - Service stations
  - PCC pump islands

**Petroleum Asphalt**

- Light Sweet / Heavy Sour

**Refinery Operation**

- FIELD STORAGE
- PUMPING STATION
- LIGHT DISTILLATE
- MEDIUM DISTILLATE
- HEAVY DISTILLATE
- RESIDUUM
- PROCESS UNIT
- ASPHALT CEMENTS
- AIR BLOWN ASPHALT
- STILL
- FOR PROCESSING INTO EMULSIFIED AND CUTBACK ASPHALTS
- PETROLEUM
- SAND AND WATER
- TUBE HEATERS
- CONDENSERS AND COUPLERS
- TOWER
- STILL
- DISTILLATION
- RESIDUUM
- OR
- GAS
- PETROLEUM
- SAND AND WATER
- CONDENSERS AND COOLERS
- TUBE HEATERS
- STEAM HEATERS
- SHELL AND TUBE HEATERS
- FIELD STORAGE
- PUMPING STATION
- LIGHT DISTILLATE
- MEDIUM DISTILLATE
- HEAVY DISTILLATE
- RESIDUUM
- PROCESS UNIT
- ASPHALT CEMENTS
- AIR BLOWN ASPHALT
- STILL
- FOR PROCESSING INTO EMULSIFIED AND CUTBACK ASPHALTS

**Asphalt Binder Properties**

- Semi-Solid
- Loading
- Liquid

- Asphalt is a *thermoplastic*
- Softens as it is heated
- Hardens as it cools
- Rate of Loading
- Heat
- Time

**Basic Types of Asphalt**

- 3 Ways to “Liquefy”
  - Heat
  - Thin w/ solvents (cutbacks)
  - Water-based emulsion

**Cutback Asphalt Grades**

- Rapid cure (RC) (Naphtha or Gasoline)
  - High volatility of solvent
  - Tack coats, surface treatments
- Medium cure (MC) (Kerosene)
  - Moderate volatility
  - Stockpile patching mix
- Slow cure (SC) (Low viscosity oil)
  - Low volatility
  - Tack coats, prime coat, dust control
Emulsions

- Dispersion of a liquid in another liquid
- Typically don’t mix
- One of the liquids is usually water

Asphalt Emulsions

- Colloid mill
  - High-speed rotor revolves
    - 1,000–6,000 rpm (17–100 Hz)
    - Clearance about 0.01 to 0.02 inches
      - 0.25 to 0.50 millimeters

Asphalt Emulsions

- Photomicrograph of an Asphalt Emulsion
  - Typically droplets are 1-20 micron in diameter

Asphalt Emulsions

Types
- Anionic:
  - Negatively charged asphalt particles
- Cationic:
  - Positively charged asphalt particles
  - Never
  - Mix the two types!
  - Store over long periods

Asphalt Emulsions

Classification
- How quickly do asphalt droplets coalesce?
- Two letter codes used to simplify + standardize
  - RS – Rapid Setting
  - MS – Medium Setting
  - SS – Slow Setting
  - QS – Quick Setting
- C designates a cationic emulsion
  - CRS, CMS, CSS
Asphalt droplets suspended in water
- Breaking
  - Contact with surface changes pH; reducing charge
- Curing
  - Evaporation leads to coalescence
  - Original asphalt characteristics return

Tack/Bond Coats
Promote Bonding between Layers

Superpave
Strategic Highway Research Program (SHRP)
- Superpave, which stands for
  - Superior
  - Performing Asphalt
  - Paved
- Performance-based specification
  - Tougther aggregate requirements
  - Asphalt grades are called
    - Performance Graded (PG) Binders

MS-19 Basic Asphalt Emulsion Manual
www.asphaltinstitute.org

PG Binders
PG 64-22
147.2 F - 7.6 F
“Performance Grade”
Minimum pavement temperature
Average 7-day max pavement temperature
Tracks; Asphalt Specifications & Installation Practices

Loading Rate of Loading
- Example
  - Mainline pavement PG 64-22
  - Toll booth PG 70-22
  - Weigh Stations PG 76-22
  
  70 mph

  Slow

  Stopping

Materials Selection
- Aggregate
  - 93 to 96% of the mix
  - Acts as the skeleton
  - Provides
    - Skid resistance
    - Stability
    - Workability
  - Quality aggregates in quality pavements
- Asphalt Binder
  - 4 – 7% of the mix
  - “Glue” or “muscle” provides
    - Waterproofing
    - Flexibility
    - Durability

Materials Selection is very important!!

Aggregate Types
- Natural
- Processed
- Synthetic
  - Round (uncrushed)
  - Single Crushed Face
  - Multiple Crushed Faces

Soundness

Aggregate Size Definitions
- 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

Standard Superpave Sieves

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Sieve Size (mm)</th>
<th>Diameter #8</th>
<th>Diameter #16</th>
<th>Diameter #30</th>
<th>Diameter #50</th>
<th>Diameter #100</th>
<th>Diameter #200</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in</td>
<td>50 mm</td>
<td>2.36 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1/2 in</td>
<td>37.5 mm</td>
<td>1.18 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 in</td>
<td>25 mm</td>
<td>0.60 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 in</td>
<td>19 mm</td>
<td>0.30 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2 in</td>
<td>12.5 mm</td>
<td>0.15 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8 in</td>
<td>9.5 mm</td>
<td>0.075 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4 in</td>
<td>4.75 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Before

After
Tracks; Asphalt Specifications & Installation Practices

Superpave Size 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>

If plant tells you:

Remember:

- 3x max aggregate
- 4x larger stone mixes

Mat Defects

- Mat thickness
- Fracture aggregate
- Open Texture
- Water intrusion

American Sports Builders Association

Section 5.0 Intermediate Pavement Course

- A leveling course of a hot plant mix having a maximum aggregate size of 3/8” to 3/4” in accordance with specifications of the state’s Department of Transportation
- And/or the Asphalt Institute
- Should be constructed over the base course to a compacted thickness of not less than 1 1/2”

Maximum Superpave 3x

- 3/8 max = 4.75 mm (3/8 x 3 = 1 1/8 inch)
- 1/2 max = 9.5 mm (1/2 x 3 = 1 1/2 inch)
- 3/4 max = 12.5 mm (3/4 x 3 = 2 1/4 inch)

American Sports Builders Association

Section 6.0 Asphalt Surface Course

- A surface course of a hot plant mix having a maximum aggregate size of 3/8” and a minimum aggregate size of 1/4”
- Should be constructed over the hotmix intermediate course to a compacted thickness of not less than 1 inch

Maximum Superpave 3x

- 3/8 max = 4.75 mm (3/8 x 3 = 1 1/8 inch)
Reclaimed Asphalt Pavements

Reclaimed Asphalt Shingles

Reclaimed Asphalt Materials

Coarse RAP  Fine RAP  RAS

Hot Mix Asphalt Compaction

Field performance has shown
- Below 3% air voids
  • Susceptible to rutting & shoving
- Over 5% air voids
  • Susceptible to raveling, oxidation
- 4% air voids typically allows for optimal design
  • Not too open
  • Little extra compaction under traffic

Hot Mix Asphalt Compaction

Reference Density Chart

For 4% Air Void Mix Design

% of Maximum Density

% of Lab Density (Gmb)

% of Control Strip Density

Reference Density Chart

In-Place Air Voids

0

1

2

3

4

5

6

7

8

9
Warm Mix Asphalt

WMA Technologies
- Several ways to classify WMA technologies
- One is by temperature reduction
  - Hot Mix Asphalt > 275 °F (135 °C)
  - Warm Mix Asphalt > 212 °F (100 °C)
  - Half-Warm asphalt mixtures < 212°F (100 °C)

Plant modifications for foaming

How Many WMA Technologies are Available in the US?
Currently Twenty Two (22) Technologies Marketed and Available in the US.

Chemical Process

Additive
Volumetric Pump
Asphalt Line Injection Point
Warm Mix Asphalt

Placement and Compaction

• "Business as usual"

Primarily use:

• Longer Season
• Early opening to traffic
• Longer hauls
• Wet weather paving
• Multi-lift construction
• Crack filler reflecting
• Workability

Warm Mix Asphalt

Pavement stays blacker, longer

Warm Mix Asphalt

http://warmmixasphalt.com/

Project Planning

Balance:

• Project Tonnage
• Hot plant output
• Length of haul
• Traffic conditions
• Number of trucks
Equipment - Paver Types

Wheeled Pavers
- Easy to operate
- Cheaper to maintain

Tracked Pavers
- Best for soft surfaces
- More stability

Understanding the Paver

Basic Functions
- Material feed
- Self-leveling

Tractor Self-Leveling
- Screed can rise & fall
  - Free Floating
- Constant line of pull when set up properly
- Smooth surface over irregular grade

Understanding the Paver

Material Feed System
Augers
- Receiving Hopper
Sensors
- Slat feeders
Gravity feed

Understanding the Paver

Flow of Material
- Hopper
- Through tunnel
- In front of screed
- Augers move mix transversely

Understanding the Paver

Material Handling
- Break Load
- Move in mass
- Avoid “tailgating”
  - Segregates
Understanding the Paver

Visual Inspection of material

Problem Indicators

- Blue smoke
- Stiff (high peak)
- Slumped
- Dry, dull appearance
- Moisture (steam or condensate)
- Segregation
- Contamination
  - Solid
  - fuel or solvents

Loading Hopper

- Avoid spillage
- Driver’s apply light brake pressure
- Removed prior to advancing
- Worker safety!

Exposing Conveyor

- Segregation
- Cold material

Basic Principle Has Not Changed

Free-Floating Screed

- Position determines mat thickness
- Screed position is
  - constant as long
  - All factors remain constant

Factors Affecting the Screed

- Head of material
- Paving speed
- Screed adjustments
- Mix design
- Temperatures
  - Mix
  - Air
  - Grade
Understanding the Paver

**Head of Material**
- Uniform flow
- Uniform force against face of screed

**Too much material**, screed will rise up

**Correct amount of material**, screed remains level

**Too little material**, screed will dip down

**Correct Elevation**

Auger Overloaded

Auger Underloaded

**Auger Extensions**

**Bulkhead Extensions**

**Paving Speed**
- Constant
- Feeders match
  - Paving speed
  - Speed changes

**Constant Speed**
- Shear force is constant
- Depth remains constant
Tracks; Asphalt Specifications & Installation Practices

Understanding the Paver
- Increased Speed
  - Shear force decrease
  - Depth decreases

Understanding the Paver
- Decreased Speed
  - Shear force increases
  - Depth increases

Understanding the Paver
- Material
  - Mix design
  - Temperatures
    - Mix
    - Air
    - Grade

Understanding the Paver
- Material Design
  - Head of Material

Understanding the Paver
- Paving Speed
  - Temperature (Air/Grade/Mix)

Understanding the Paver
- Mixtures Changes
  - Compaction varies
  - Adjust thickness to match desired mat thickness

Understanding the Paver
- Screed Adjustments
  - Tow Point
    - Fixed on Tractor Unit
    - Screed pivots

Understanding the Paver
- Tow Arm
Understanding the Paver

Turning the Depth Crank Increases or Decreases the Paving Angle of Attack

Angle of attack
• Changes amount of material flow under screed

Understanding the Paver

Angle of Attack
• Screed nose & grade
• Nose up attitude
• Screed reaches equilibrium

Increase Angle of Attack
• More material passes under screed
• Screed rises to new level

Understanding the Paver

Increased Angle of Attack:
• Screed climbs
• Forces balanced
• Achieves equilibrium
• Returns to original angle

Reaction to Angle of Attack Changes

– 65% of change
– 35% of change in the last 4 lengths

Takes over 5 tow arm lengths
• 8 foot tow arm vs 78 ft court length
• One change = ½ court length
Tracks; Asphalt Specifications & Installation Practices

Understanding the Paver

Main Screed Crown
- Main screed “broken”
- Positive or negative

Uniform Texture
- Even texture full width
- Zero crown

Understanding the Paver

Lead Crown Low
- Open texture in center
- Tight on sides
- Add 3 mm (1/8") crown

Lead Crown High
- Tight, shiny strip in center
- Open texture on sides
- Reduce lead crown

Understanding the Paver

Joint Construction
- Center tow point
- Set width
- Set crown
- Set extender slope & height
- Use boards that allow for compaction rate

Joint Construction
- Null screed
Joint Construction

Introduce angle of attack
Crank until resistance is felt

Fill auger chamber half full
Conveyor manually
Auger manually
Shovel if needed

Transverse Joints - Starting a Lane

Straight lines
- Offsets
- Edge/center line
- Stringline
- Position of Guides

Understanding the Paver

Overlap Mat Defects

Longitudinal Joints;
- Avoid overlap

Overlap Mat Defects
Transverse Slope Control

Slope Sensor

Uses pendulum as a reference to slope across mat

Mat Defects

Grade Conditions

- Leveling courses

Correct

Incorrect

Mat Defects

Surface Patching

- Partial depth
- Infrared heater
- Heat existing pavement
- Add material
- "Weld" to surrounding material
- Straight edge
- Compact
- Do not overheat

Mat Defects

Segregation

- Course mix is susceptible
- Cold spots in truck or hopper
- Aggregate stockpile

Mat Defects

Truck-end segregation

- Uniformly spaced
- Segregation in the truck transfers the paver

Mat Defects

Screed Alignment

- Main Screed
- Gates
- Full Extensions.