New Methods in Asphalt QA/QC Testing
Common QC/QA tests

- Gradation of Individual Stockpiles
- Moisture Content of Aggregates
- Viscosity Testing of the Asphalt Binder
- Moisture Content of Mix
- Asphalt Content: Ignition test or Nuclear AC Gauge
- Gradation of Recovered Aggregate
- Maximum Theoretical Specific Gravity of the Mix
- Laboratory Density using the Gyratory Compactor
- Temperature of the Mix
- In-place (Roadway) Density of Compacted Mat
- Joint Density
- Smoothness of Mat
QC/QA State of Practice

• Over the past 20 years, many changes have been made in quality control and acceptance of HMA.
• More responsibility for testing has shifted to the Contractor.
• Specifications have become more complex.
• Additional tests are required being for product Acceptance.
• HMA production rates have increased. QC focus is on testing the end product and not controlling the process.
And those dang researchers...

• Are constantly coming up with new tests, such as:
  – Permeability testing
  – Thermal imaging for identifying temperature and/or mix segregation
  – Bond strength testing
  – So called simple performance tests
• If we are demanding higher quality, is the answer more tests?
Fundamental Questions to Ponder?

• What should the owner agency test/measure to assure that it has received quality materials and construction?

• What should the contractor test/measure to assure that it has produced quality materials and construction?

• Are the tests necessarily the same?

• Do the tests ensure good performance?
The Answer is…

• I don’t know
• It depends
• It begins with NO

So how can we make the situation better?

• I don’t know
• Let’s use new technology
Automated QC Technologies

1. Belt Sampling
2. Moisture Content
3. Gradation
4. Binder Viscosity
5. Asphalt Content
6. HMA Temperature

Continuous Mix Plant
Possible Advantages of Automated QC Tests

• Faster results
• More frequent data
• More consistent data

• All should lead to better decision making and higher quality HMA
Belt Sampling Devices

• a.k.a. – Belt Sweeper
• Removes a sample of aggregate while the plant is running.
• Belt sampler on the aggregate incline conveyor and the RAP conveyor.
• Sized for belt capacity (production rate) and desired sample mass.
Belt Sampler

- A mature technology.
- Appears to do a good job of sampling aggregate and RAP.
- Sampling material at drop off from head pulley may be better.
Automated Moisture Contents

• Accurate moisture content of aggregate and RAP are needed to adjust belt scale readings for continuous mix plants.

• Accurate moisture contents are also needed to evaluate the efficiency of the plant’s drying system.

• Current practice of measuring moisture contents of aggregates is labor and time intensive.
Moisture Content of Materials

1. Microwave Moisture Probes
   • Continuous or discrete measurements

2. Automated sample Drying Unit (ADU)
   • Discrete sample measurements
   • Used in conjunction with automated sample gradation device
Moisture Content Probes

- Measure moisture content of aggregate on belt using microwave technology.
- Requires calibration for each mix.
- Data can be used to adjust weight reading of the belt scale.
Moisture Content Probes

- Retractable system to minimize probe wear - gives only discrete measurements.
- Funnel device added to crowd RAP onto probe face.
Aggregate Sample Drier

- Receives sample from belt sampler and dries it.
- Programmable sample size
  - Usually 8 to 14 Kg
  - if sample mass is below the limit, then another belt sweep is made.
- Electrically heated chamber with air blown through sample.
- When constant weight is reached, test ends and sample drops to automatic gradation unit
Automated Moisture Content

• Using microwave probes mounted on aggregate incline belt requires time consuming calibration for each mix.
• Alternate microwave probe locations should be evaluated.
• The prototype automated drying unit is slow, needs additional development.
Automatic Gradation Unit

Sieves
12.5 mm
9.5 mm
4.75 mm
2.36 mm
0.60 mm
AGU versus Lab Gradation

Mix 1 - Permeable HMA Base

\[ y = 0.9613x + 1.421 \]
\[ R^2 = 0.928 \]
AGU % Passing

Dry Gradation % Passing

y = 1.0013x + 1.4306

$R^2 = 0.9849$
AGU versus Lab Gradation

Mix 3 19.0 mm NMAS mix with RAP

$y = 0.848x + 2.9826$

$R^2 = 0.8275$
Automated Gradation of Aggregates

• Prototype AGU works reasonably well, some improvements are needed.
• Technician-free results
• Current limitations:
  – Only six sieves
  – Dry gradation only
  – Unable to determine RAP aggregate gradation
Other Automated Gradation Technologies

• Video (vision) based gradation devices
  – Gradation
  – Particle shape and texture
  – e.g. J.M. Canty Inc., used by Rinker quarry near Miami

• New automated washed gradation system
  – Plant scale system is being designed from a laboratory device
  – Moisture content of aggregate part of process
  – Agg Master from Castonis & Assoc.
Automated Asphalt Content

**Batch Plants**

\[
\%AC = \frac{\text{Asphalt Mass in Batch (tons)}}{(\text{Asphalt Mass} + \text{Dry Aggregate Batch Mass (tons))}}
\]
Automated Asphalt Content

Continuous Mix Plants

\[ \%AC = \frac{\text{Binder flow rate (tons/hr)}}{(\text{Binder flow rate + Dry aggregate flow rate (tons/hr)})} \]

- Dry aggregate flow rate is determined from belt scale and moisture content measurements.
- Assume that fine aggregate removed by dryer exhaust system is returned at the same rate to the mixing point.
Asphalt Content
Using the Plant’s Automated Controls

Binder flow rate (gal./min. → tons/hr) is continuously measured with a meter or a non-powered, positive-displacement pump.

Aggregate and RAP feed rates (tons/hr) are measured with belt scales, tachometers and a computer integrator.
Belt Scale Calibration

• Proper calibration of belt scales using material over the weigh bridge and diverted to a tared truck.

• Better standards are needed on plant calibration
  – Methods
  – Training
  – Frequency
  – Documentation
Asphalt Meter Calibration

• Calibration tanks can be used to verify the asphalt meter
• Hands-free, therefore safer, faster, and more accurate
In-Line Viscometer & Temperature System

- Measures the viscosity & temperature of the binder.
- Mounts in line from AC tank to injection point.
Automated Binder Viscosity

• Viscosity appears to be a simple indicator of binder grade.
• Variability of some in-line measurements need to be further investigated.
• Other binder modification systems need to be evaluated.
Mix Temperature Gauge

- Mix temperature is often monitored by the plant operator, usually at the point of discharge from the mixer.
Mix Temperature

• Automated measurement of mix temperature is important and it works.
• We should make better use of this information.
• Future work should consider locating IR temperature sensor at loadout point and print mix temperature on ticket.
Data Collection
Data Management
Robotic Truck Sampling
Intelligent Compaction
Down the Road

• This is the 1st Step
• Improvements can be made with modifications
• Other automated technologies are being developed
• Information gaps need to be filled by new technologies
• Looking for ideas from other industries
Thank You