University of Illinois Urbana-Champaign
Bituminous Conference, DEC2013
Timothy R. Murphy, P.E.
Murphy Pavement Technology, Inc.

OBTAINING THE HIGHEST QUALITY ASPHALT MIXES
IAPA QC Managers Mission

- Identify opportunities to improve Illinois hot mix asphalt specification.
- Promote an appropriate balance of better safety, higher quality, and lower cost.

QC Managers Group and IDOT Experts Approach

- Dive into minutiae,
- Recognize opportunities,
- Identify action items,
- Learn from others,
- Lead from learning.
IAPA QC Manager Action Items

- Reduction of Mix Designs
- ABR & % of RAP/FRAP/RAS
- Limits of Precision & Appeal Process
- Edge of Pavement
- Continuing Education
- Positive Dust Control

Reducing Variability

**Less is More**
What is PFP? [Risk]

- **Buyer’s Risk** – the probability that the buyer would accept material which is of unacceptable quality on the basis of the test results
- **Seller’s Risk** - the probability that good quality material would be rejected as unacceptable on the basis of the test results

What is PWL? [Mean (Average)]

The average of a set of \( n \) numbers.

\[
X = \frac{\Sigma x_i}{n}
\]

\( X \) = arithmetic mean
\( x_i \) = individual test results
\( n \) = number of tests
What is PWL? [Std. Dev. (Spread)]

The **standard deviation** \(s\) is a statistic that tells you how tightly all the various examples are clustered around the mean in a set of data.

\[
S = \sqrt{\frac{n \sum (x)^2 - (\sum x)^2}{n(n - 1)}}
\]

---

The Bean Machine

(invented by Francis Galton)

The first generator of normal random variables.
5’ 4.3” and 5’ 9.9”

Estimate of Population Improves with Increasing Number of Samples

Relative Frequency, %

Asphalt Content (%)
What is PWL? [PWL Concept]

![Image of normal distribution with area calculations]

Normal Distributions with Different Means and Std. Dev.
Skew

- Normal: Skew = 0
- Right (Positive) Skew
- Left (Negative) Skew

Aggregate Gradation

Going in...
How worn flights affect temperatures

Silo & Truck loading
Dumping Hopper Wings

Auger Extensions Missing
Raking the Longitudinal Joint

Inclement Weather
Sample Location

More is Less

(Aggregate top size = ¼”, ⅜”, ½”, ¾”, 1”)

Gyration Level
- N30
- N50
- N70
- N90
- N105

Gyration Level
- N30
- N50
- N70
- N90
- N105

PG46-34
PG58-28
PG64-22
PG64-28
PG70-22
PG70-28
PG76-22
PG76-28

Dense Graded Stone Matrix Asphalt

Hamburg for most?
Less is More
(Aggregate top size = ¼”, ⅜”, ½”, ¾”, 1”)

Gyration Level
N30
N50
N70
N90
N105

Hamburg for some? 30% Recycle

3.5% Voids & Regression
Dense Graded Stone Matrix Asphalt
Less is More

- Less mix designs.
- Less chance for error.
- Less yard space.
- Less variability.
- Less chance of supplying the wrong mixture.
- Less cost.
- More streamlined.
- More uniformity.
- More efficient.
- More consistent.
- More acceptability.
- More lane miles paved.

LESS

MORE

To begin, let's go to Murphy's Law, Corollary 6:

"Whenever you set out to do something, something else has to be done first."
Dense Graded Asphalt Research

Fine Graded HMA

ICT R27-79

Illinois Center for Transportation
Varying Design Philosophies

United States Bureau of Public Roads 0.45 Power Chart
Sieve Sizes Raised to the 0.45 Power

Figure 5-7
Open Graded

Open-graded mixtures are:

- Coarse mixtures with little sand-sized material.
- High-void, open-textured mixture.
- Difficult to keep the asphalt on the rocks during production and construction.

Momentum = mass \times velocity
WHAT IS THE HIGHEST QUALITY ASPHALT POSSIBLE?

What is the highest quality asphalt?
- Durable,
- Flexible,
- Economical,
- Consistent,
- Homogeneous,
- Smooth,
- Compactable.
Which mix we want, Fine v. Coarse Graded?

Neither, we want uniformly or ‘medium’ graded asphalt.
Opportunities for Enhancement

- **IL-19.0 mm (3/4”) binder mixture:**
  - Minimum of 40% passing the #4 sieve
  - Minimum of 80% passing the ½” sieve

Bracketed designs will not cause any undue extra expense.

- **IL-9.5 mm (3/8”) surface mixture:**
  - Minimum of 40% passing the #8 sieve
  - Minimum of 60% passing the #4 sieve
  - 3.5% Air Voids

Agencies and Contractors

- Village of Cary
- Town of Streamwood
- Kendall County
- City of Elgin
- Village of Oak Brook
- Village of Evanston
- Village of Algonquin
- City of North Chicago
- Arrow Road
- Curran Asphalt
- Geske
- Peter Baker
- D Construction
- Gallagher Asphalt
Case Study, Intermodal Yards

- 42% passing #4,
- 3.5% Voids,
- 30% RAP,
- N90.
Case Study, Airfields

United States Bureau of Public Roads 0.45 Power Chart
Sieve Sizes Raised to the 0.45 Power

BLUE REPRESENTS
FEDERAL AVIATION ADMINISTRATION
Potential Misunderstanding

Whether you design for a coarse, fine, or medium graded HMA base, intermediate, or wearing course your optimum asphalt content will be the same when using the same materials, targeting the same VMA and Voids level, provided the asphalt $P_{ba}$ absorptions are the same.

- (Pine, B. & Murphy, T.)

Are They All The Same?
Measuring Asphalt Success

Take-Away (aka Deliverables)

- Understand Risks
- Improve Methods
- Update Technology
- Consider Options
- Develop Future Action Items
Questions?

YOU OK?

I SHOULD HAVE LET YOU KNOW I WAS STOPPING.