BALANCED MIX DESIGN APPROACH

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Initial Thoughts

Dry mixes are prevalent in our industry.

Restrictive specifications and general notes are not long term solutions.

Lowering N-design and raising lab molded densities will only help so much.

Continuing to increase binder replacement without addressing mix performance is not sustainable.

We need to increase our understanding of the factors which drive mix performance to help us better optimize our mixes.
It’s a Nationwide Problem

Several tests sections on NCAT test track are dedicated to investigating long term pavement performance.

Researchers across the country are looking at better ways to design longer lasting pavements.

NAPA recently created the Pavement Performance Task Group in response to concerns over states issues with pavement performance.
Some Questions We Need to Ask Ourselves

Is going to SP the answer?

Is getting rid of RAP and RAS the answer?

Is disallowing modifiers like REOB and PPA the answer?

IS DOING THINGS THE WAY WE’VE ALWAYS DONE THEM THE ANSWER?

What about traffic and climate? Are universal volumetrics (e.g., VMA and air voids) controlling designs without regard to traffic and climate?
A Better Approach

LET’S STOP USING THE RECIPE TO DETERMINE IF THE CAKE IS GOOD

We need to define our expectations and open up the recipe to meet the end result

- What defines a good cake?
- What defines a good mix?

It Tastes Good
Lasting Performance

**Optimized Mix Design Approach Foundational Points**

- “Use what works”
- “Eliminate what doesn’t”
- “Be simple and practical”

“Good doesn’t have to be complicated and complicated isn’t always good.”
What We Need And What You Want

Design For Performance, Not Economics

CONTRACTORS WANT A LEVEL PLAYING FIELD
What is a Balanced Mix Design?

**Balanced Mix Design**

- Optimize the mix to provide needed performance and balance between stability and durability.
Optimized Mix Design Approach – Framework

Mix Performance Evaluation
- Stability
- Durability

BALANCE
Optimized Mix Design Approach – Asphalt Mixes

Mix Performance Evaluation
- Stability
- Durability
Balanced Mix Design Approach - PG 70-28

**Equations and Graphs:**

\[ y = 2E-07x^{12.635} \]
\[ R^2 = 0.9829 \]

\[ y = 698467x^{-2.4408} \]
\[ R^2 = 0.9505 \]

**Graph Details:**

- **X-axis:** Asphalt Content (%)
- **Y-axis:** Number of Passes (12.5 mm Rut Depth)
- **Legend:**
  - HWT
  - OT

**Data Points:**

- **HWT:**
  - 5.3
  - 5.4

- **OT:**
  - 5.7
  - 5.4

**Graph Analysis:**

The graph illustrates the relationship between asphalt content and the number of passes required to achieve a 12.5 mm rut depth. The equations provided represent the mathematical models used to describe this relationship. The HWT and OT data points are plotted on the graph, indicating the number of passes required for each asphalt content percentage tested.
Optimized Mix Design Approach – LRA

Mix Performance Evaluation

Stability

Durability

Cantabro
Balanced Mix Design Approach – Limestone Rock Asphalt

Cantabro Loss, %

Hveem Stability

- Type I D Fine
Optimized Mix Design Approach – Framework

Material Selection
- Aggregates
- Binder, Modifiers & Additives
- Recycled Materials

Optimize JMF
- Gradation
- Binder Content
- Volumetrics

Mix Performance Evaluation
- Stability
- Durability
- Adjustments

Workability
- Mixing
- Compaction
- Segregation
Optimized Mix Design Approach – Framework

- **Material Selection**
  - Aggregates
  - Binder, Modifiers & Additives

- **SAC Frictional Properties**
- **ΔTc MSCR (COMPATIBILITY)**
ΔTc using BBR

Binders with ΔTc > 6°C
Optimized Mix Design Approach – Framework

- Optimize JMF
  - Gradation
  - Volumetrics
- Bailey Method
- VMA
Optimized Mix Design Approach - Evaluation

- Mix Performance Evaluation
  - Stability
  - Durability
Hamburg Analysis

**Rut Depth vs. Number of Wheel Passes**

- **Consolidation**
  
  Even after compaction, the sample continues to consolidate for the first few wheel passes.
  
  \[ \Delta V > 0 \]

- **Stripping Point**
  
  The sample begins stripping, which contributes to an increasing rate of rutting.

- **Inverse stripping slope**

- **Slope is the inverse of creep.**
The fracture energy and crack retardation rate are plotted together on a design interaction plot.

\[ G_f = \frac{W}{A} \]
Overall View of All Mixtures

- Critical Fracture Energy, lbs-in./in.2
- Crack Progression Rate
- TOUGHNESS
- FLEXIBILITY

Graph showing the relationship between TOUGHNESS and FLEXIBILITY with critical fracture energy and crack progression rate.
Example – Lab Standard Mix

- SuperPave Type D
- PG 70-22
- Limestone Aggregate SAC B
Final Thoughts

There is a lot of work at the national level already in progress towards utilizing this type of approach.

Constraints:
- Large ships turn slow
- A change in our thought process