Mixture & Strategy Selection
(Breakout Session 5)

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Today’s Asphalt Mixtures

- Since the adoption of Superpave mixtures in the late 1990’s and early 2000’s, most states have seen major improvements with regards to rutting, the major asphalt pavement distress of the 1970’s and 1980’s
Today’s Asphalt Mixtures

- Improvements in both aggregate quality and requirements, as well as, a performance based testing and grading system for asphalt binders, have played a major role in addressing asphalt pavement stability problems.
Today’s Asphalt Mixtures

- However, with some of the methodologies that have been adopted, many states are now seeing the “balance” tip too far in the other direction, and are experiencing asphalt pavement durability problems.
Today’s Asphalt Mixtures

- Today’s Common Pavement Distresses
  - Cracking
  - Raveling
  - Stripping
  - Durability

So, what’s the problem?
Common Problem: Pavement Durability

• In general terms, based on the evolution of our asphalt pavements, it is accepted that the primary functions of the two primary asphalt mixture components follow these “Rules of Thumb”:
  – Aggregates: provide strength, stability, and load-carrying capacity
  – Asphalt Binder: provides durability and flexibility under loadings

• With that in mind, it is commonly accepted that durability problems such as cracking, raveling, and stripping, are primarily a function of the asphalt binder content

So, we don’t have enough asphalt binder in the mix?
Non-Recycled (Virgin) Mixtures

• With non-recycled mixtures, low asphalt binder contents are typically caused by one of the following:
  – not properly accounting for asphalt absorption
  – increase in dust content, thus decreasing VMA
  – the loss of VMA during production and thus decreasing the asphalt content to meet the air voids requirement
  – production automation problems: pumps, weigh bridge, asphalt meter, aggregate moisture, etc...
Recycled Mixtures

• With recycled mixtures, low asphalt binder contents can be caused by those same problems, but also can be related to:
  – increased total dust percentage due to RAP fines, thus decreasing VMA
  – incorrectly proportioning RAP due to inaccurate RAP moisture content
  – high moisture contents in RAP can hinder the softening of the RAP binder that is needed to blend with virgin binder, thus coating “black rocks” and reducing the total binder content for the recycled mixture

These are all production issues, but what about the mix design?
Mix Design Strategies to Combat Low Asphalt Mixtures

- Adjusting volumetric design and production requirements
- Lowering design level of compaction (gyrations)
- “Superpave 5” Mix Design
- Gyratory Regression
- Air Voids Regression
- Balanced Mix Designs
Asphalt Content is driven by:

- Voids in the Mineral Aggregate (VMA) available after compaction and the target VTM (Air Voids)
- VMA available is controlled by the aggregate properties, blend gradation, mixture viscosity and the compactive effort
- So, to increase the amount of asphalt binder in a mixture, we must either increase VMA, decrease the target VTM, reduce the compactive effort, or some combination of these

But are they all equivalent approaches?
Adjusting Volumetric Design and Production Requirements

• Adjusting the Target VTM (Air Voids)
  – Some state agencies have attempted to combat low asphalt mixtures by adjusting the target VTM (air voids) requirements during design and production
  – Other volumetric parameters (VMA, VFA, etc...) are the same, simply targeting a lower design air voids to determine optimum asphalt binder percentage
  – Typically the commonly used 4.0% target is reduced to either 3.5% or even 3.0%
  – This approach is essentially allowing for a little more asphalt in the produced mixture
• Adjusting the VMA Requirements
  – Some state agencies have attempted to combat low asphalt mixtures by adjusting the VMA requirements during design and/or production
  – Some have held the design requirement the same while decreasing the production requirement 0.5%
  – Some have increased the design requirement 0.5% while keeping the production requirement the same
  – Others have increased both the design and production requirements 0.5%
  – Each of these are essentially allowing for a little more asphalt in the produced mixture
Lowering Design Level of Compaction

• Lowering the Gyrations
  – Another strategy to combat the low asphalt mixtures has been to lower the level of compaction used in design
  – “Locking Point” studies were performed to help states verify the number of gyrations necessary to “lock” the aggregates together without over-compacting the mixture
  – Essentially, many states decreased their design level of compaction, thus leaving more asphalt in the final mixture
“Superpave 5” Mix Design

- Mixtures are designed to have the same density in the lab and in the field.
- Optimum binder content is chosen at 5.0% air voids rather than the currently specified 4.0%.
- Thus, this approach would also decrease the in-place air voids target from 7.0% - 8.0% down to 5.0% percent.
- To maintain the same volume of effective asphalt content, the minimum VMA requirement is increased by 1.0%.
- The design compactive effort is also decreased to 50 gyrations.
• Gyratory Regression
  – The design is performed using 90 gyrations and a target VTM (air voids) of 4.0%, meeting the standard specs.
  – Next, while holding the design aggregate structure constant, the compaction effort is reduced to 60 gyrations and the final design asphalt content is selected at 4.0% VTM (air voids).
  – This approach is based on the principle that simply lowering the number of gyrations would not necessarily result in increased asphalt content, as the mix designer would likely change the aggregate structure to keep the asphalt content relatively low and competitive.
• Air Voids Regression
  – The asphalt mixture is initially designed using 75 gyrations with the Superpave gyratory compactor.
  – The minimum VMA requirement is 0.5% higher than the standard Superpave requirements.
  – The design aggregate structure is selected based on 4.0% VTM (air voids), but the final design asphalt binder content for that structure is selected at 3.0% VTM by using the air void regression technique.
  – This typically results in about a 0.3% increase in the design asphalt binder content.
Adjustments to Mix Designs

• NCAT Report 17-05
  – Making adjustments to the asphalt mixture design to obtain a higher optimum asphalt content can successfully lead to higher in-place densities.
  – Reducing the number of gyrations during mix design resulted in increased density in the field.
  – It is important that a satisfactory mix be designed and produced to ensure good performance and that this mix be compacted to adequate density in the field.
  – As a word of caution, adding additional asphalt solely for compaction changes the mixture properties and this adjusted mix should only be used if laboratory test results have shown that the performance of the mix is satisfactory.
So, what is a Balanced Mix Design?

• Balanced Mix Design Definition
  – “Asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate and location within the pavement structure.”
  – Basically, it consists of designing the mix for an intended application and service requirement.
  – There are essentially 3 main approaches that agencies are following
So, what volumetric properties should we aim for?

- Balanced Mix Design
Approach #1: Volumetric Design with Performance Verification

- Basically, it is straight Superpave with verifying performance properties; if the performance is not there, start over and re-design the mix. Volumetric properties would have to fall within existing M323 limits. Example States: Illinois, Louisiana, New Jersey, Texas, Wisconsin
**Approach #2: Performance-Modified Volumetric Design**

- The initial design binder content is selected using M323/R35 prior to performance testing; the results of performance testing could ‘modify’ the mixture proportions (and/or) adjust the binder content – and the final volumetric properties may be allowed to drift outside existing M323 limits. Example State: California
Approach #3: Performance Design

• This approach involves conducting a suite of performance tests at varying binder contents and selecting the design binder content from the results. Volumetrics would be determined as the ‘last step’ and reported – with no requirements to adhere to the existing M323 limits. Example States: New Jersey w/ draft approach
The objective of the mix design process is to select and proportion materials to obtain the desired qualities and properties in the finished pavement.

The goal is to determine, within the contract specifications, a cost-effective blend of aggregates and a corresponding asphalt binder content that yields a well-performing mixture.

It is often referred to as a “balancing act”, trying to balance just the right proportions of aggregate and asphalt binder to resist the two primary distresses of rutting and cracking.
Objective of Mix Design

It’s a Balancing Act!!!

Rutting
Shoving
Flushing

Cracking
Raveling
Stripping
References

• NCAT Report 17-05: “Demonstration Project for Enhanced Durability of Asphalt Pavements Through Increased In-Place Pavement Density”
  • http://www.eng.auburn.edu/research/centers/ncat/files/technical-reports/rep17-05.pdf
References


• http://eng.auburn.edu/research/centers/ncat/newsroom/2017-spring/balanced-mix
Questions?

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