Optimizing Laboratory Mixture Design as it Relates to Field Compaction in Order to Improve Hot Mix Asphalt Durability

SPR-3624
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Background

- Indiana pavements generally reach end of live because of durability issues
  - Typically cracking caused in part by oxidized binder
  - Rutting has been significantly reduced
- Reducing permeability (to air) decreases rate of binder aging
- Mixes designed at 4% air voids can be placed in the field at lower densities, in some cases with air voids > 9%
- Above 8% air voids, permeability increases dramatically
Achieving lower air void contents in the field would improve durability by decreasing binder aging.
Requires changing the mix design.
If we target higher voids in mix design, the designed mix will be somewhat easier to compact in lab and field.
Important to keep effective binder content the same for durability.
Design at 5% and compact to 5% – then keep the voids at that level (reduce traffic densification).
Objective

- Optimize HMA lab mix design compaction as it relates to field compaction in order to increase in-place durability without sacrificing rutting resistance.

- Additional compaction equipment should not be needed in the field but roller patterns (including speed, frequency and number of passes) may vary.
Precedent

- Laboratoire Central des Ponts et Chaussées (LCPC)
  - Developed in 1960s-1970s
  - Design and construct to ultimate density; no post construction densification
  - Design compaction selected to match construction densities under pneumatic tired roller
  - Gyratory compaction similar to Superpave gyratory
  - Design effective binder content fixed for each mix type; select aggregate structure to provide desired air voids (range 4-8%)
  - Field density requirement = 95% (lifts generally thicker than US)
  - Little to no additional compaction under traffic
Precedent

Ministère de Transports de Québec (MTQ)

- Wanted to implement LCPC method but compactors were hard to get and $$$
- Merged LCPC with Superpave gyratory
- Effective binder volume fixed as in LCPC
- Field density requirement = 92% (similar lift thicknesses to US)
Approach

- Start with some example current mix designs
  - 9.5 and 19 mm
  - Category 3 and 4 (~50% of INDOT work)
  - Dolomite, limestone and blast furnace slag with PG 64-22
  - RAP and RAS included (to be realistic)

- Adjust gradation to achieve 5% voids at different gyrations
  - 100 gyration mixes will be adjusted and compacted at 70, 50 and 30 gyrations
  - Bailey method will be used to guide adjustments
  - Maintain air voids, VMA and binder content in 5% void mixes
Approach (continued)

- Test mechanical properties of the mixes
  - Want to achieve the same (or better) mechanical properties in the lower air void mixes as the original mix provided
  - Do not sacrifice rutting resistance for higher density
  - Tests will include flow number and dynamic modulus
  - Test 100 gyrations mix at 7% and others at 5% air voids
  - Determine number of gyrations to achieve 5% air voids and similar (or better) mechanical properties

- Field Validation
  - Can we achieve higher densities with revised mix design?
Deliverables

- Revised lab compaction and mix design procedure
- Field validation plan
- Draft revised test methods
- Draft special provisions
- Training (for implementation phase)
INDOT wants trial project **next season**

Need enough data to make recommendations before summer

- Have materials and are “shaking rocks” now

Final report will follow

18 month project (7/1/2011 – 12/31/2012)
Study Advisory Committee

- Gerry Huber
- Dave Andrewski
- Michael Prather
- Kurt Sommer
- Tommy Nantung
- Tom Duncan
Advisors

- Gerry Huber
- Brad Cruea
- Bill Pine

- Meeting frequently to develop plans, choose mixes and materials, adjust designs, etc.
Anticipated Implementation

- Implementation first on several trial projects
- If favorable, wider implementation possible
- No new equipment or increases in testing/design time
- Minimal training needed
- Minimal costs for implementation
Anticipated Benefits

- Potential 2-3 years of increased service life
- Potential savings of $20-30 million a year
  - Based on $300 million HMA rehab budget and that 50% of the HMA pavements reaching end of life do so because of durability problems
Plug

North Central Asphalt User Producer Group Technical Conference

Downtown Indianapolis

February 15-16 (1st choice) or February 22-23 (2nd choice)

NCSC Steering Committee and NCAUPG Management Committee meetings on preceding afternoon

Details will be on the web -- Link from NCSC page or http://cobweb.ecn.purdue.edu/~spave/NCAUPG/Index.html
NCAUPG Topics

- Energy/Recycling/Sustainability
  - RAP, RAS and WMA

- Binders
  - MSCR Test, Mixing and Compaction Temperatures

- Plant Operations and Innovations
  - Plant Innovations, QC, Continuous Plant Monitoring

- Pavement Design and Performance
  - MEPDG, Cold Temperature Study

- Constructing Safe and Durable Pavements
  - Intelligent Compaction and PavIR, Safety Edge, Centerline Corrugations, etc.
Questions?

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