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

Concept

- 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 gyration 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)

Time Frame

- 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 PaveIR, Safety Edge, Centerline Corrugations, etc.

Questions?

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