HMA Spec Revisions and Testing 2018

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HMA Specification Revisions and Testing 2018

- HMA Specification Revisions
  - History until 2017
  - 2017 to now
- HMA Testing Changes
  - From area labs to three regional testing centers
  - Spec-related testing changes
  - Test strips

HMA Specification Revisions

- 2013
  - INDOT started to notice HMA binder contents were slipping downward
  - Pavements were cracking prematurely
  - Mixes looked “dry”
  - But why?
  - Don’t we test for binder content?

HMA Specification Revisions

- HMA Mix Design
  - Air Voids

    Shock Absorbers
  - Binder content

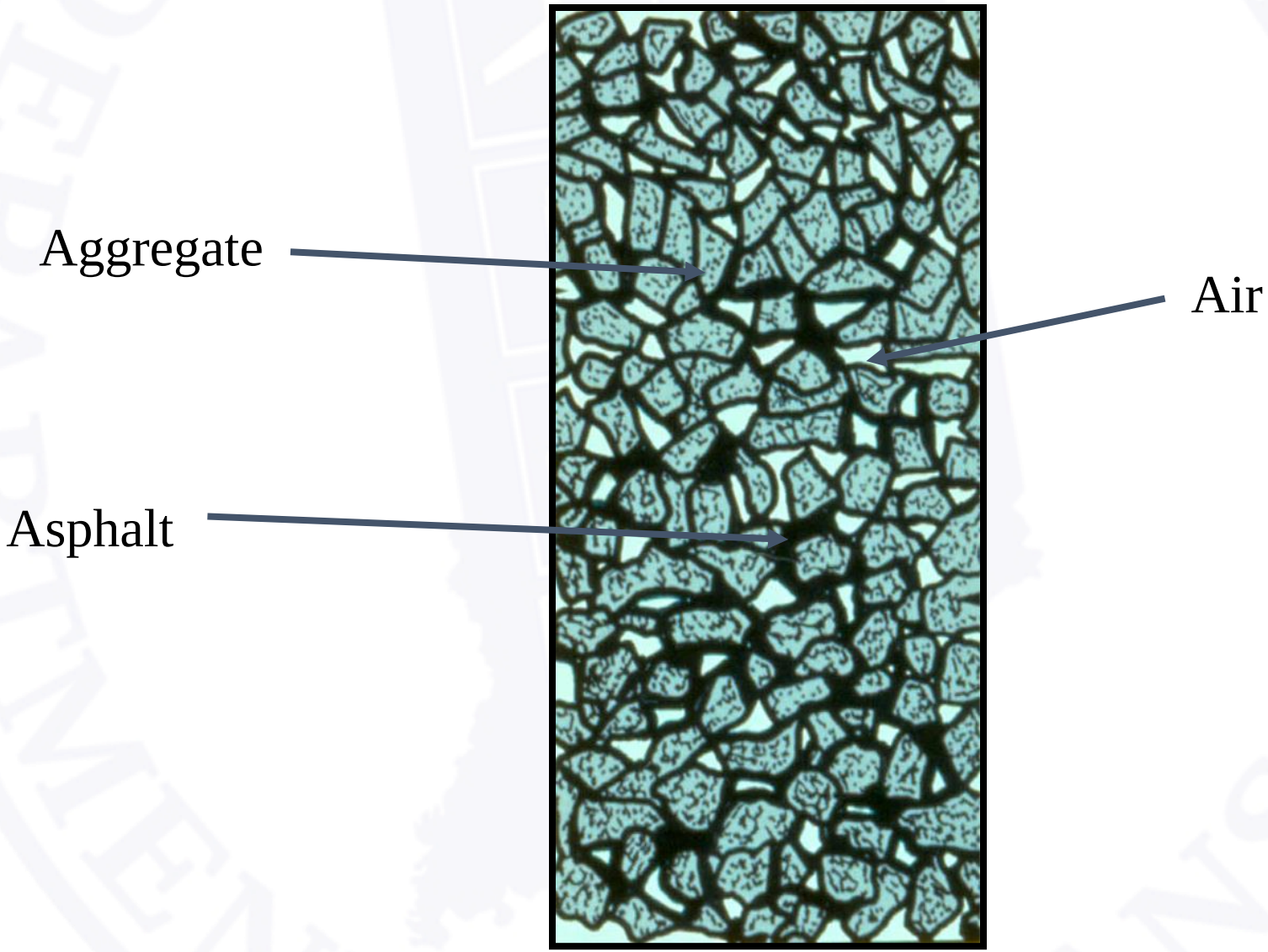
    The Glue

    - Voids in the Mineral Aggregate (VMA)
      - Minimum VMA required for sufficient binder content
      - Binder content target set based on this

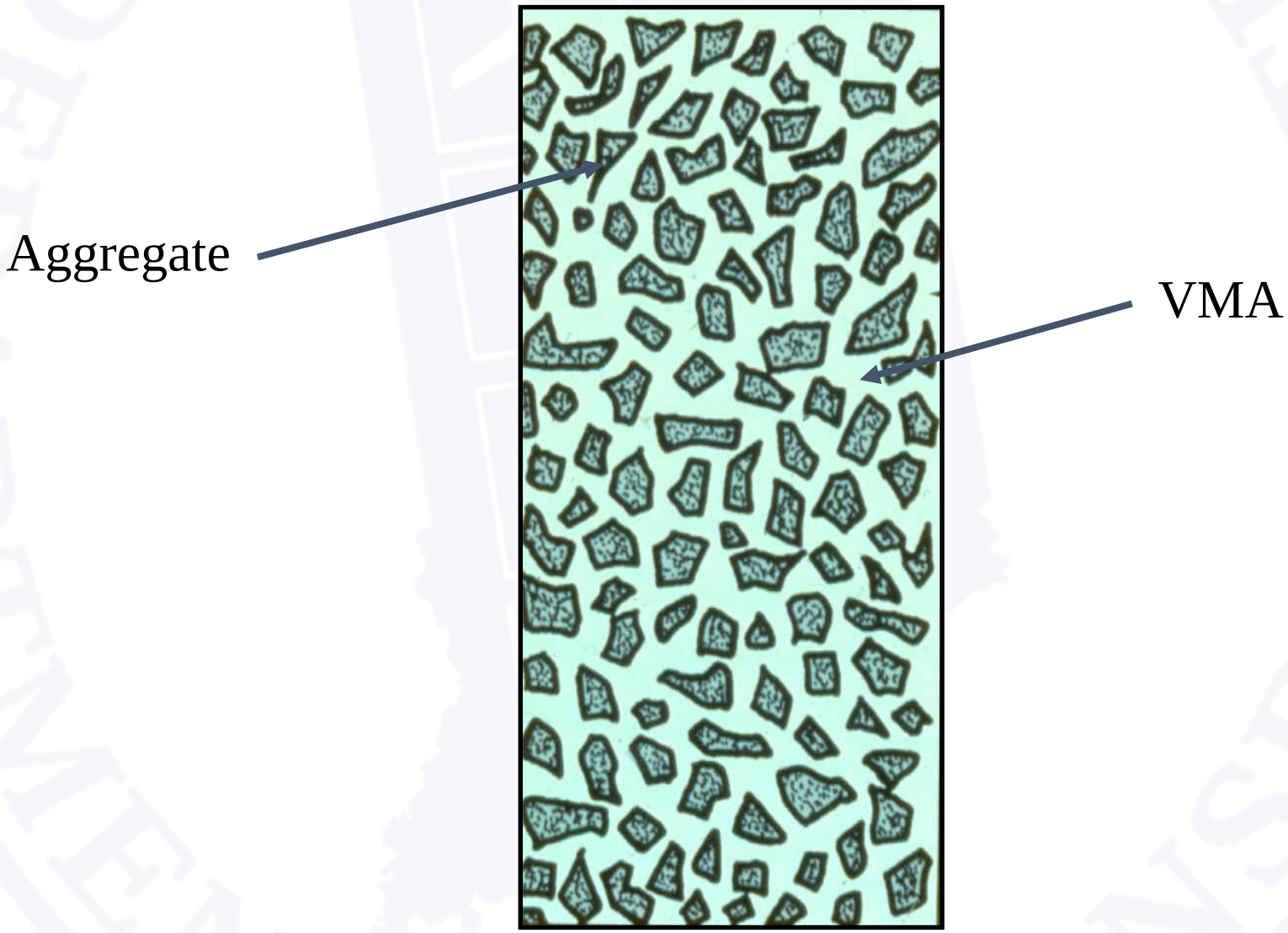
HMA Specification Revisions

- What is VMA?
  - The space in a compacted HMA mixture not taken up by aggregate

HMA Specification Revisions



HMA Specification Revisions

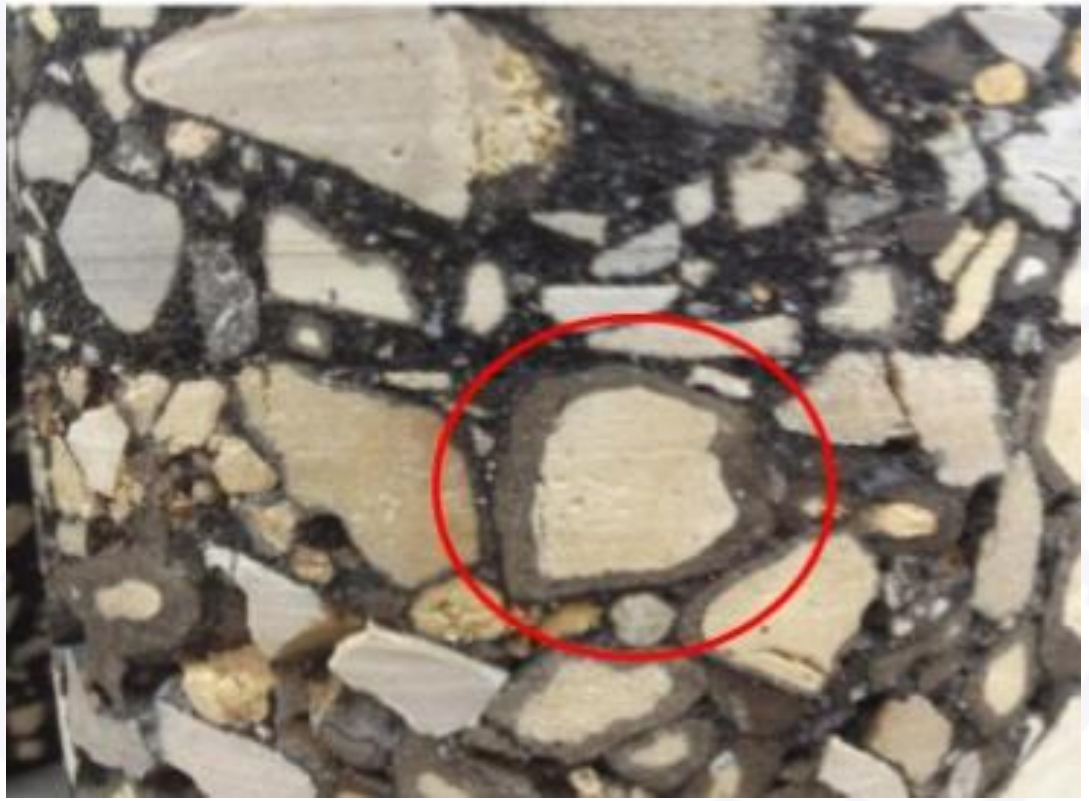


HMA Specification Revisions

- What is VMA?
  - A measure to ensure a mixture has enough effective asphalt content
- Effective Asphalt Content (Pbe)
  - Amount of asphalt available for use as binder
- VMA = Effective Asphalt + Air Voids

HMA Specification Revisions

- Pbe = Total Asphalt – Asphalt Absorption
- Asphalt Absorption (Pba)
  - Binder inside the aggregate not available for use as binder
  - Expensive filler



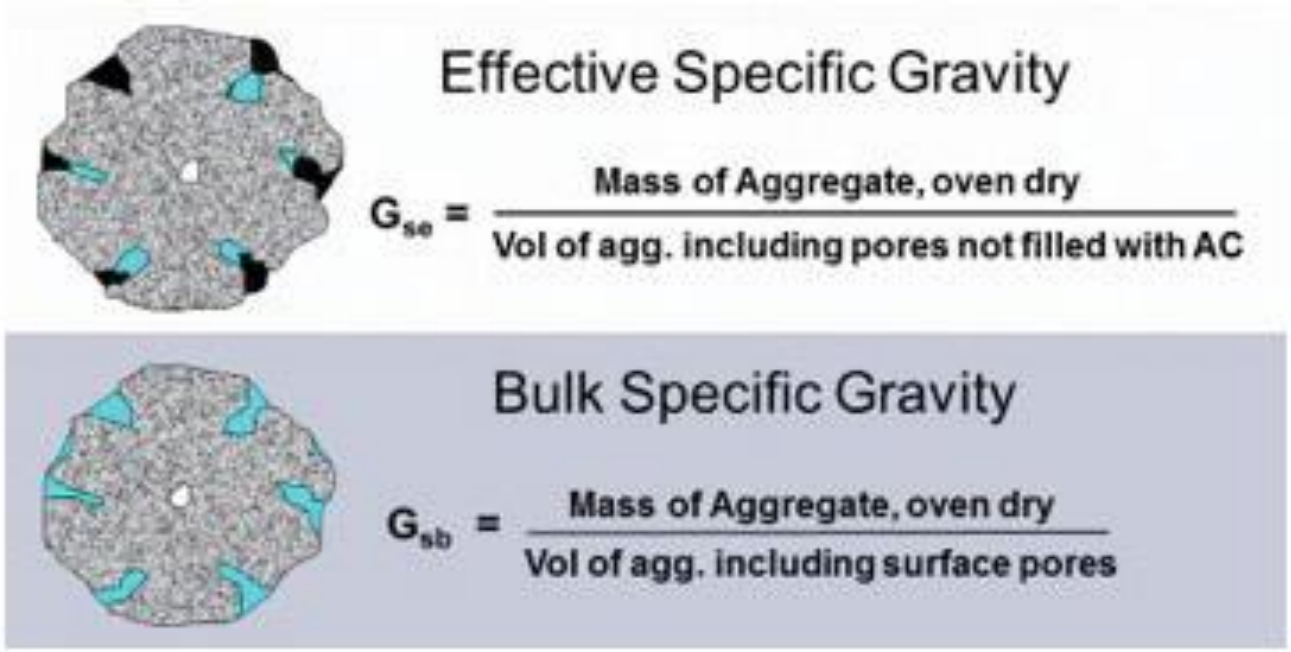
HMA Specification Revisions

- Where is all of this going?

- How do we measure Asphalt Absorption?

HMA Specification Revisions

- Asphalt Absorption



- Gse = easy from HMA sample
- Gsb = hard from HMA sample

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HMA Specification Revisions

- VMA
  - Bulk Specific Gravity of Pill (Gmb)
  - Binder Content (Pb)
  - Bulk Specific Gravity of Aggregate (Gsb)

HMA Specification Revisions

- VMA
  - Bulk Specific Gravity of Pill (Gmb)
  - Binder Content (Pb)
  - **Bulk Specific Gravity of Aggregate (Gsb)**
    - **Hard to determine from HMA sample**
    - **Used Gsb as submitted on mix design**

HMA Specification Revisions

- VMA
  - Bulk Specific Gravity of Pill (Gmb)
  - Binder Content (Pb)
  - **Bulk Specific Gravity of Aggregate (Gsb)**
    - **Hard to determine from HMA sample**
    - **Used Gsb as submitted on mix design**

- **What happens if the Gsb is wrong?**

HMA Specification Revisions

- VMA
  - What happens if the Gsb is wrong?

$$VMA = \left[100 - \left(\frac{Gmb(1 - Pb)}{Gsb} \right) \right]$$

  - Gsb ↓ , VMA ↓
  - Gsb ↑ , VMA ↑

HMA Specification Revisions

- VMA
  - What happens if the Gsb is wrong?

$$VMA = \left[100 - \left(\frac{Gmb(1 - Pb)}{Gsb} \right) \right]$$

  - Gsb ↓ , VMA ↓
  - Gsb ↑ , VMA ↑

  - If the Gsb is wrong, target binder content is wrong

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HMA Specification Revisions

- Mix Design Review
  - Focused on Aggregate Bulk Specific Gravity (Gsb)
  - Gsb values tended to be higher than INDOT tested values
  - This Inflated VMA
  - Kept Binder Content too low

HMA Specification Revisions

- Mix Design Review
  - Focused on Aggregate Bulk Specific Gravity (Gsb)
  - Gsb values tended to be higher than INDOT tested values
  - This Inflated VMA
  - Kept Binder Content too low

- So what did we do?

HMA Specification Revisions

- 2014
  - Gsb List
    - Contractors required to use INDOT values for Gsb
    - Flaws:
      - Gsb list = averages
        - May not represent current material when variable
        - Used statewide average value for RAP
      - Allows for “material substitution”
        - Intentional or not
      - Static Gsb values can cause other problems

HMA Specification Revisions

- 2015
  - Delta Pb
    - Comparison between provided Binder Content and “Expected” Binder Content
    - Flaws:
      - Still uses Gsb list averages

HMA Specification Revisions

- Need a way to determine Gsb during production
  - Extract and determine Gsb from field samples

This was the main driver for the HMA spec changes

HMA Specification Revisions

- 2018 Changes
  - Binder Content by Extraction
  - Determine Gsb from extracted sample
  - Gsb will change throughout season
  - ITM 597

HMA Specification Revisions

- 2018 Changes
  - Test Strips
    - Plate samples taken (no cores)
      - INDOT/Consultant will test samples
      - Volumetric testing (for information)
      - Gsb determined from extracted sample
    - One required per calendar year per DMF
    - Can be located on INDOT project, or off site
    - 10 day *maximum* shut down period after test strip paving

HMA Specification Revisions

- 2018 Changes
  - Test Strips

The total aggregate bulk specific gravity, Gsb, value will be determined in accordance with ITM 590 from acceptance plate samples for dense graded 9.5 mm, 12.5 mm, 19.0 mm, and 25.0 mm mixtures following every 5,000 t of base and intermediate or every 3,000 t of surface produced for a DMF at a certified HMA plant. The frequency may be reduced at the direction of the Engineer.

If the ITM 590 Gsb value has deviated no more than ± 0.010 from the DMF value, the DMF value will not change.

If the ITM 590 Gsb value has deviated more than ± 0.010 from the DMF value, the Department determined ITM 590 Gsb value will be used. The Department will notify the Contractor in writing of the ITM 590 Gsb value. The ITM 590 Gsb value will replace the Gsb of the DMF on subsequent sublots following the date of notification.

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HMA Specification Revisions

- 2018 Changes
  - Test Strips

A test strip in accordance with ITM 597 shall be required for dense graded 9.5 mm, 12.5 mm, 19.0 mm and 25.0 mm mixtures with original contract pay item quantities greater than or equal to 1,000 t of base and intermediate or 600 t of surface. The test strip shall be constructed as part of the first 300 t of DMF production or the Engineer may allow the test strip construction to be located off the paving project if requested by the Contractor. Plate samples shall be obtained from the test strip in accordance with ITM 802 and ITM 580.

A maximum ~~ten~~ 10 business day production shutdown for the DMF shall accompany the completion of the test strip in order for the Contractor and Engineer to conduct mixture testing.

One test strip is required for each submitted DMF per calendar year.

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HMA Specification Revisions

- 2018 Changes
  - Test Strips
    - Passed Standards Committee in July
    - However, there were some concerns with:
      - What if Gsb test is an “outlier?”
      - Could lead to incorrect adjustment of mixtures
      - Do we really need test strips on as small as one sublot?

HMA Specification Revisions

- INDOT met with APAI Steering Committee throughout the fall
- Modified ITM 597 to be both:
  - QC/QA Test Strip and Gsb Procedures
- Issued Construction Memo 18-01
  - Revises RSP 401-R-661

HMA Specification Revisions

The total aggregate bulk specific gravity, Gsb, value will be determined in accordance with ITM 597.

A test strip in accordance with ITM 597 shall be required for each submitted DMF per calendar year for each dense graded 9.5 mm, 12.5 mm, 19.0 mm and 25.0 mm mixture with original contract pay item quantities greater than or equal to 5,000 t of base and intermediate or 3,000 t of surface. The test strip shall be constructed as part of the first 300 t of DMF production or the Engineer may allow the test strip construction to be located off the paving project if requested by the Contractor. Plate samples shall be obtained from the test strip in accordance with ITM 802 and ITM 580.

A maximum 10 business day production shutdown for the DMF shall accompany the completion of the test strip in order for the Contractor and Engineer to conduct mixture testing.

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HMA Specification Revisions

- Test Strips
  - Why?
    - Gsb!
  - So what?
    - Air Voids
      - Gmb of pill, Gmm of mix
    - Density
      - Gmb of core, Gmm of mix
    - VMA
      - Gmb of pill, binder content, Gsb of aggregate
  - Gsb was only value not tested from production mix sample
  - We want to get it right!

HMA Specification Revisions

- Test Strips
  - Gsb established as 3 point moving average
    - DMF Gsb (from mix design lab)
    - Test Strip Gsb
    - Lot 1 Sublot 1 Gsb
  - Gsb testing approximately once per lot on each DMF
  - If new 3 point average changes less than 0.010, then established Gsb won't change

HMA Specification Revisions

- Test Strips
  - Outliers
    - If single tested Gsb value changes by more than 0.050
    - And, Gse changes by more than 0.030 in same direction
    - Then, additional verification testing will occur at OMM
    - No “established Gsb” changes until verification testing complete

HMA Specification Revisions

- Test Strips
  - Planning
  - Communication
  - Flexibility
  - We want to hear feedback and suggestions for improvement

HMA Specification Revisions

- 2017 Changes
  - Eliminated Category 1 and 5

ESAL CATEGORY	ESAL
~~1~~	~~< 300,000~~
2*	~~300,000 to~~ < 3,000,000
3	3,000,000 to < 10,000,000
4*	≥10,000,000 ~~to <~~ ~~30,000,000~~
~~5~~	~~≥ 30,000,000~~

**A category 2 mixture shall replace a category 1 mixture and a category 4 mixture shall replace a category 5 mixture.*

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HMA Specification Revisions

- 2017 Changes
  - 4 hour mix conditioning

401.05 Volumetric Mix Design

The DMF shall be determined for each mixture from a volumetric mix design by a design laboratory selected from the Department's list of approved Mix Design Laboratories. A volumetric mixture shall be designed in accordance with AASHTO R 35 and the respective AASHTO reference as listed below. *All loose mixture shall be conditioned for 4 h in accordance with AASHTO R 30 prior to testing. Steel furnace slag coarse aggregate, when used in an intermediate or base mixture application, shall have a deleterious content less than 4.0% as determined in accordance with ITM 219.*

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HMA Specification Revisions

- 2017 Changes
  - Delta Pb (Binder Content)
    - Introduced in 2015 as a design check
    - Compares Design Pb to “Expected” Pb
      - Thus the “Delta”
    - Expected Pb calculated using minimum Effective Pb and 65% of H_20 absorption

The optimum binder content shall produce *a* $\Delta Pb \leq 0.20$ *as determined in accordance with ITM 591 and* the following air voids at N_{des}:

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HMA Specification Revisions

- 2017 Changes
  - RAP/RAS
  - Now a maximum of 25% BR
  - Maximum of 15% BR or 3% total RAS

MAXIMUM BINDER REPLACEMENT, %									
Mixture Category	Base and Intermediate						Surface		
	Dense Graded				Open Graded		Dense Graded		
	25.0 Mm	19.0 Mm	12.5 mm	9.5 Mm	25.0 mm	19.0 mm	12.5 Mm	9.5 mm	4.75 mm
~~1~~	~~40.0*~~				~~25.0~~		~~40.0*~~		
2	~~40.0~~ *25.0* *				25.0*		~~40.0~~ *25.0* *		
3	~~40.0~~ *25.0* *				25.0*		25.0*		
4	~~40.0~~ *25.0* *				25.0*		25.0*		
~~5~~	~~40.0*~~				~~25.0~~		~~25.0~~		

~~*RAS materials shall not contribute more than 25% by weight of the total binder content for any HMA mixture.~~

**The contribution of RAS to any HMA mixture shall be ≤ 3.0% by total mass of mixture and ≤ 15.0% binder replacement.*

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HMA Specification Revisions

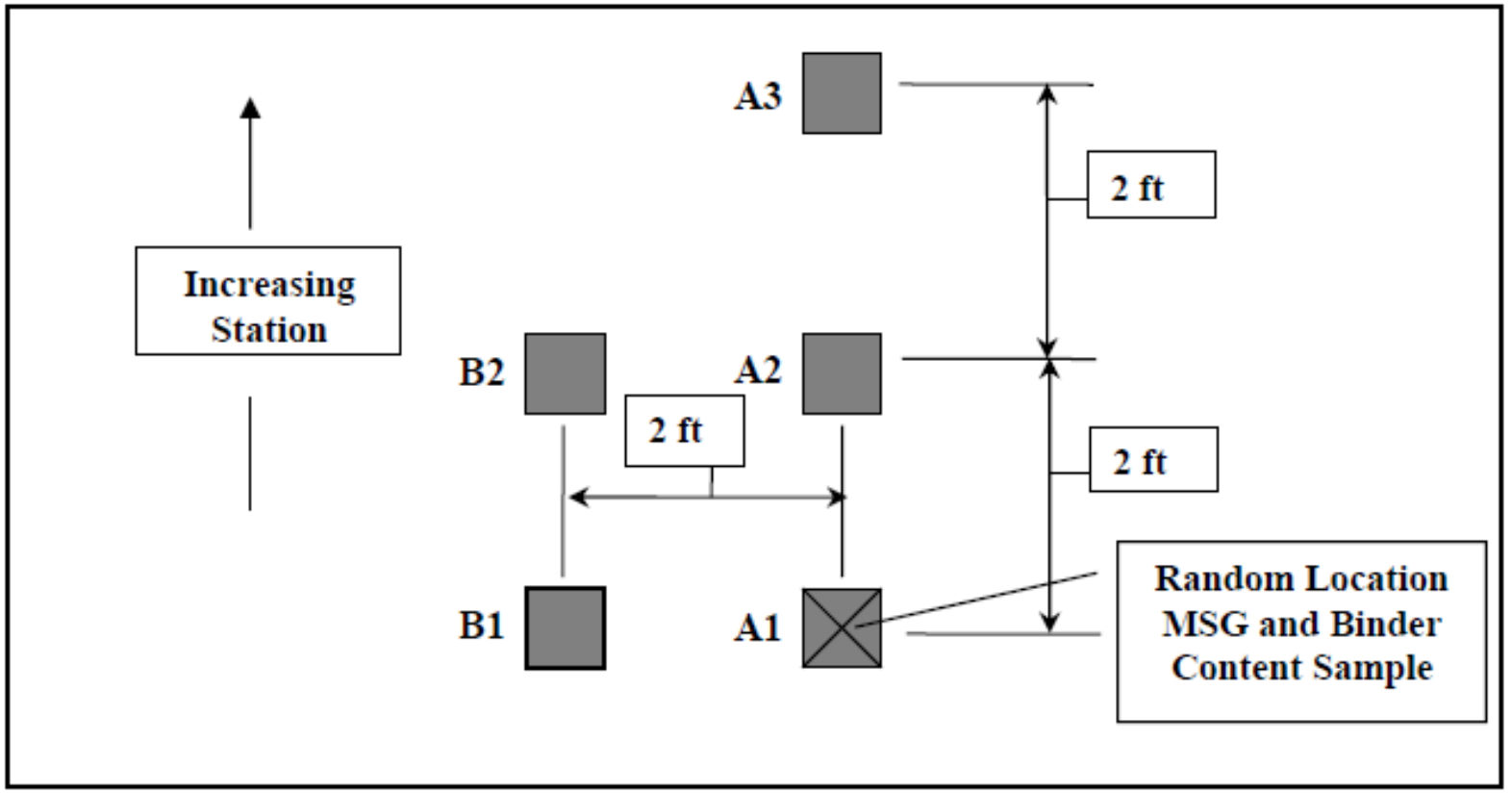
- 2017 Changes
  - JMF Eliminated (for 401/402)
  - Nothing left to adjust (I'll explain more in a minute)

HMA Specification Revisions

- 2017 Changes
  - Will be determining the following values throughout production:
    - Effective Specific Gravity (Gse)
    - Dust/Calculated Effective Binder Ratio
    - Volume of Effective Binder
  - At this point, no pay factors or other acceptance criteria
  - Required QC monitoring

HMA Specification Revisions

- 2017 Changes
  - 5th Plate



HMA Specification Revisions

- 2017 Changes
  - Mix Temperature
  - Max temperature now 315/325 at paver

portion of the mixture for each. The temperature of each mixture at the time of spreading shall not be more than ~~18°F below the minimum mixing temperature as shown on the JMF for mixtures compacted in accordance with 402.15~~ *315°F whenever PG 64-22 or PG 70-22 binders are used or not more than 325°F whenever PG 76-22 binder is used.*

HMA Specification Revisions

- 2017 Changes
  - PWL Equations

Estimated PWL greater than 90:

~~PF = (105.00-0.50 x (100.00-PWL))/100~~

$$PF = ((0.50 \times PWL) + 55.00)/100$$

Estimated PWL greater than or equal to 50 and equal to or less than 90:

~~PF = (100.00 - 0.000020072 x (100.00 - PWL)$^{3.5877}$)/100~~

$$PF = ((0.625 \times PWL) + 43.75)/100$$

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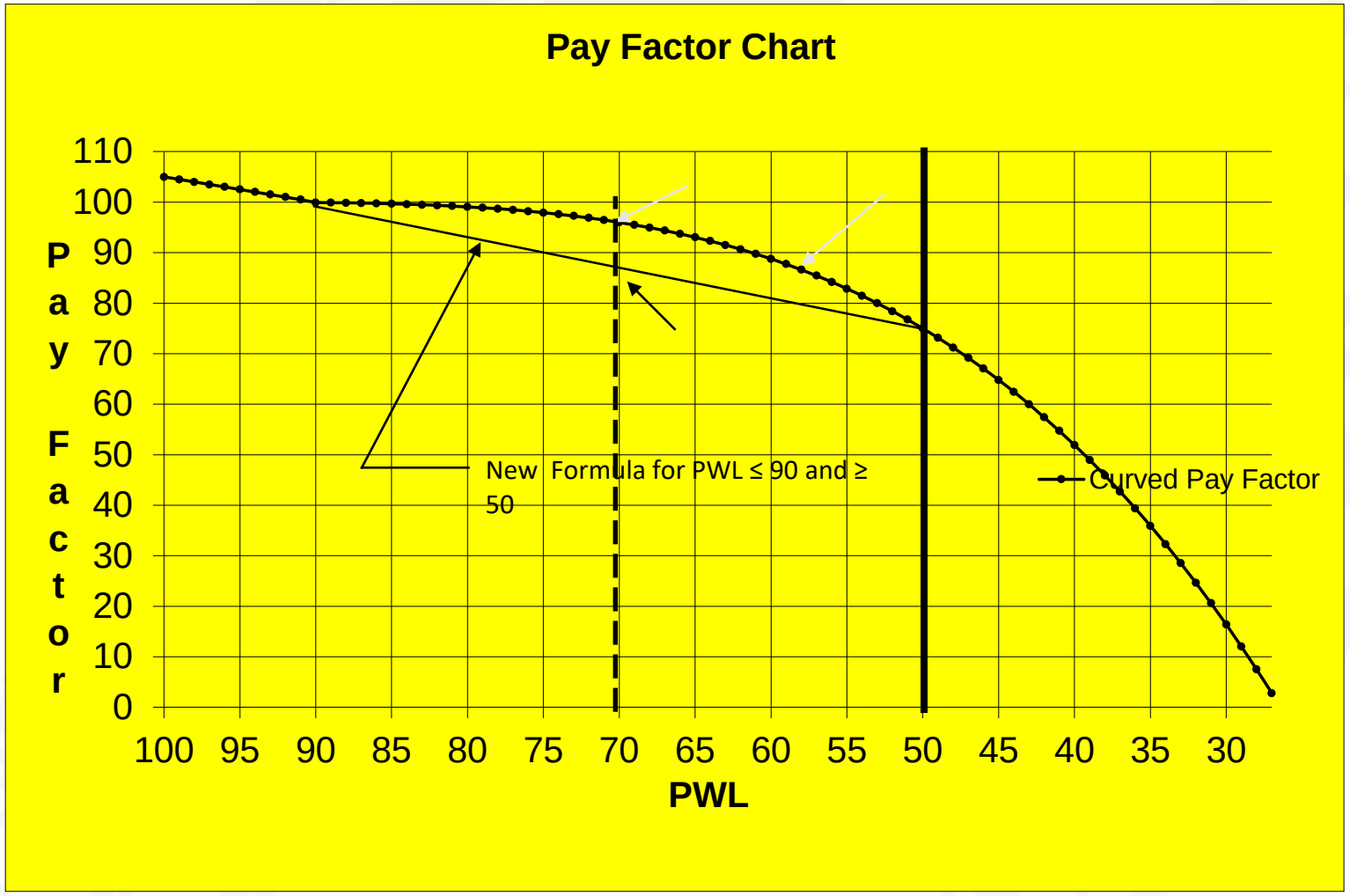
HMA Specification Revisions

- 2017 Changes
  - PWL Equations



HMA Specification Revisions

- 2017 Changes
  - Pay Factors

$$\text{Lot PF} = \sout{0.20(PF_{BINDER}) + 0.35}\ 0.30(PF_{VOIDS}) + \sout{0.10}\ 0.35(PF_{VMA}) + 0.35(PF_{DENSITY})$$

where:

Lot PF= Lot Composite Pay Factor for Mixture and Density

$\sout{PF_{BINDER}}$ $\sout{= \text{Lot Pay Factor for Binder Content}}$

PF_{VOIDS} = Lot Pay Factor for Air Voids at N_{des}

PF_{VMA} = Lot Pay Factor for VMA at N_{des}

$PF_{DENSITY}$ = Lot Pay Factor for In-Place Density, %Gmm

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HMA Specification Revisions

- 2017 Changes
  - Pay Factors

SPECIFICATION LIMITS		
MIXTURE		
	LSL*	USL**
Air Voids at N_{des}, %	2.60	5.40
Voids In Mineral Aggregate at N_{des}, %	Spec	Spec + 2.50
DENSITY		
	LSL*	USL**
Roadway Core Density (% Gmm), %	91.00	n/a
* LSL, Lower Specification Limit ** USL, Upper Specification Limit		

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HMA Specification Revisions

- 2017 Changes
  - Pay Factors

VMA		
Dense Graded Deviation from Spec Minimum	Open Graded Deviation from Spec Minimum	Pay Factor
> + 3.0		Submitted to the Office of Materials Management*
≥ + 2.5 and ≤ + 3.0		1.00 minus 0.05 for each 0.1% over + 2.5%
≥ + 2.0 and < + 2.5		1.05 minus 0.01 for each 0.1% over + 2.0%
> + 0.5 and < + 2.0		1.05
≥ 0.0 and ≤ + 0.5	All	1.05 minus 0.01 for each 0.1% under + 0.5%
≥ - 2.0 and < 0.0		1.00 minus 0.05 for each 0.1% under 0.0%
< - 2.0		Submitted to the Office of Materials Management*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.		

HMA Specification Revisions

- 2017 Changes
  - Appeals Changes
    - QC data required prior to release of QA data
    - Appeals allowed based on deviation of QC results from QA results
    - $500 credit for each appealed sublot that did not improve SCPF/Lot PF

A $500.00 credit adjustment will be included in a quality adjustment pay item in accordance with 109.05.1(e) for each appealed sublot that did not result in an improvement to the SCPF or Lot PF.

HMA Specification Revisions

- 2017 Changes
  - Aggregate Revisions
    - CAA/FAA Changes

FINE AGGREGATE ANGULARITY		
TRAFFIC ESAL	DEPTH FROM SURFACE	
	≤ 4 in.	> 4 in.
~~< 300,000~~	~~(Note 1)~~	
~~300,000 to~~ < 3,000,000	40 (Note 1)	40
3,000,000 to < 10,000,000	45	40
≥ 10,000,000 ~~to < 30,000,000~~	45	40
~~≥ 30,000,000~~	~~45~~	~~45~~
Note 1: For 4.75 mm mixtures, the fine aggregate angularity shall be ~~40 for < 300,000 ESAL and~~ 45 for ~~300,000 to~~ < 3,000,000 ESAL.		

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HMA Specification Revisions

- 2017 Changes
  - Aggregate Revisions
    - CAA/FAA Changes

COARSE AGGREGATE ANGULARITY		
TRAFFIC ESAL	DEPTH FROM SURFACE	
	≤ 4 in.	> 4 in.
~~< 300,000~~	~~55~~	
~~300,000 to~~ < 3,000,000	75	50
3,000,000 to < 10,000,000	85/80*	60
≥ 10,000,000 ~~to <~~ ~~30,000,000~~	95/90*	~~80/75*~~ 95/*90**
~~≥ 30,000,000~~	~~100/100*~~	~~100/100*~~
* Denotes two faced crush requirements.		

HMA Specification Revisions

- 2017 Changes
  - Aggregate Revisions
    - SMA Aggregate

SF slag, sandstone, crushed dolomite and polish resistant aggregates in accordance with 904.03(a) may be used in SMA mixtures provided the mixture is designed in accordance with ITM 220.

    - ITM 220 Requirements:
      - Micro-Deval = 18.0% or less
      - Aggregate Degradation = 3.0% or less

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HMA Testing Changes

- 14 Area Labs to 3 Regional Labs
- Consultants and INDOT
- Sample Logistics
- How will this affect you?

The Future

- Superpave5
  - Design a mix at 5% air voids
  - Target 5% AV (95% density) in field

SPECIFICATION LIMITS		
MIXTURE		
	LSL*	USL**
Air Voids at N_{des}, %	~~2.60~~ *3.60*	~~5.40~~ *6.40*
Voids In Mineral Aggregate at N_{des}, %	Spec	Spec + 2.50
DENSITY		
	LSL*	USL**
Roadway Core Density (% Gmm), %	~~91.00~~ *93.00*	n/a
* LSL, Lower Specification Limit ** USL, Upper Specification Limit		

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The Future

- Superpave5
- 3 Pilot Projects Completed to date
  - SR 13 – Middlebury
    - Control Density = 91.8%, S5 Density = 94.7%
  - Georgetown Rd. – Indianapolis
    - Control Density = 92.2%, S5 Density = 95.7%
  - US 40 – Richmond
    - Control Density = 93.3% , S5 Density = 95.4%

The Future

- Superpave5
- 12 more “pilot” projects this year
  - 2 per District
  - Research project to document how projects go this year
- First time through letting process
- If all goes well, will be standard practice

The Future

- Superpave5

The Future

- Superpave5

At the **North Central Superpave Center** in West Lafayette, a joint project between Purdue University and the Indiana Department of Transportation, engineers have helped create a new asphalt mixture that has fewer air pockets. The concept, first developed in France, provides fewer spaces inside the pavement for water to absorb and expand. The result is less cracking and fewer potholes. (Some air voids are necessary in asphalt to give the material room to expand and contract based on temperature.)

2006	43
2001	43
2000	43
2003	42
1999	40
1998	40
1997	38
2016	37
2005	37
1995	37
2018	36
2010	36
2011	35
1996	35
2017	34
1994	34
2014	27

The asphalt, named "**Superpave 5**" because it has only 5 percent air voids inside the mixture, is now being tested at three sites around the state. Engineers say those field tests, which include a stretch of Georgetown Road in Indianapolis, have been encouraging.

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The Future

- Performance Testing
- “Balanced Mix Design”
  - Cracking Test
    - Semi Circular Bend (SCB)
  - Rutting Test
    - Hamburg Wheel Tracker
  - Durability Test?
    - Cantabro

The Future

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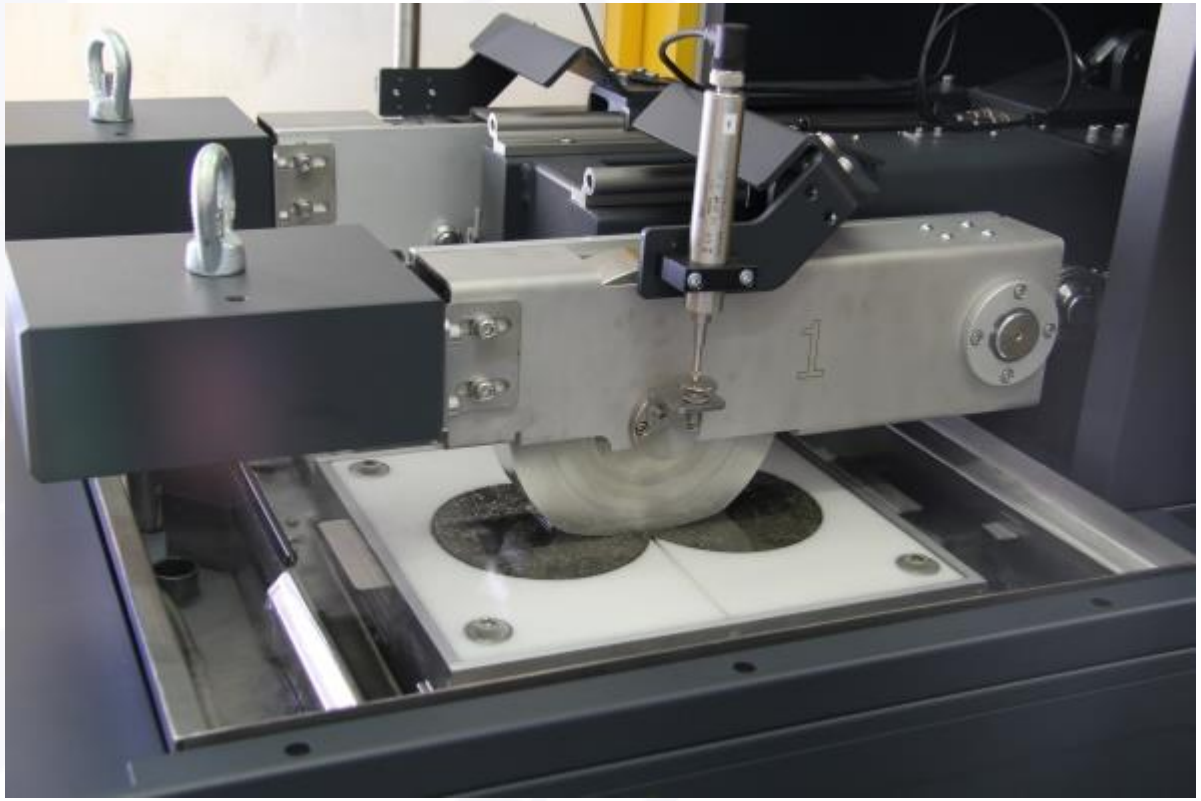

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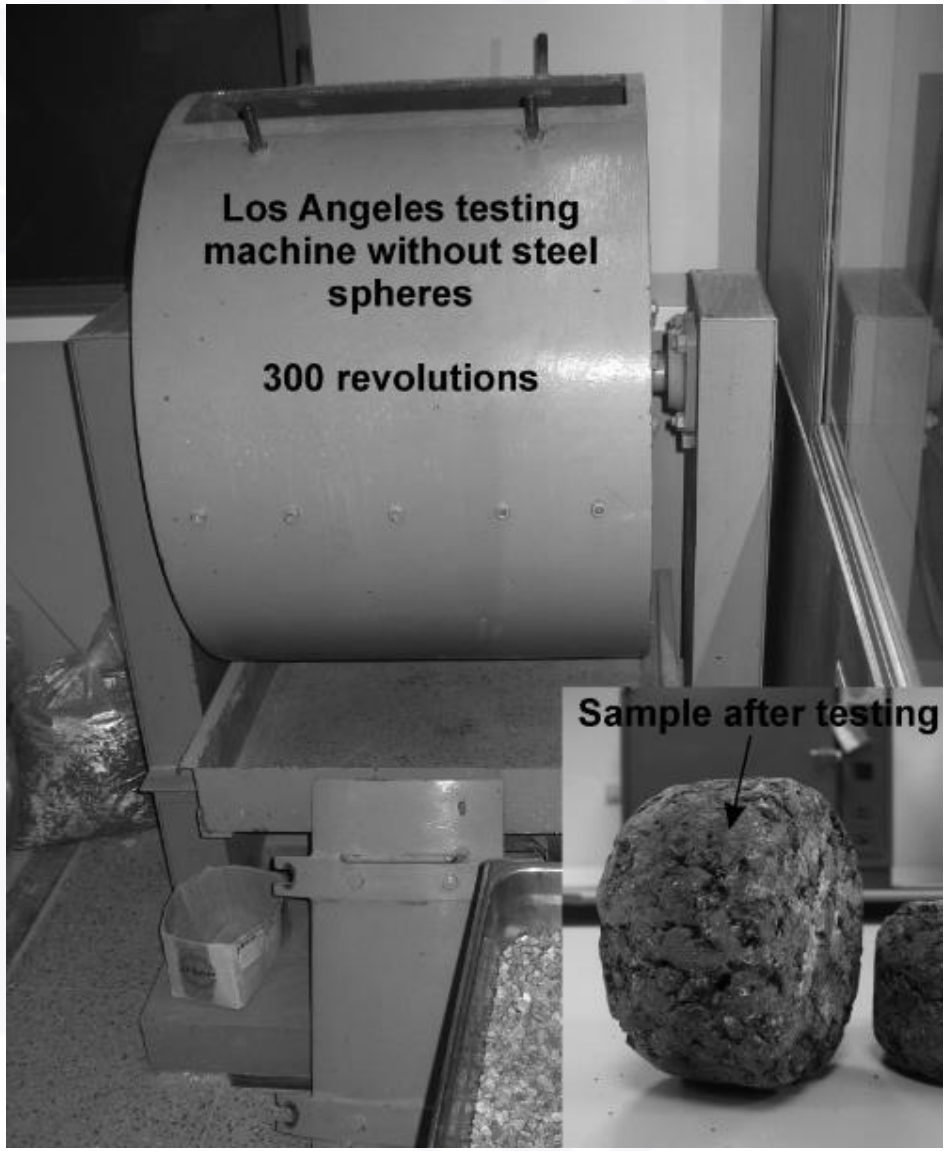

The Future

- Performance Testing
- “Balanced Mix Design”
  - “Superpave Plus”?
  - Field Verification?
  - Full on Acceptance Testing?
- More to come!

Thank you!

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