Hot Mix Testing Recertification

Quality Control / Quality Assurance
DOT Employee Timesheet Information

Charge to Office Overhead

AFE- 71B5

Function- 1174
**IMPORTANT**

Recertification is only for individuals currently certified and actively participating on Asphalt Concrete Projects (must attend certification class every 8 years)

PDH’s available from SDDOT Certification Office

Call/email Jerry Schaefer 605 (773-5661), Bryce Chambers 605 (773-7042) or Sheila Jandt 605 (773-3403) to request PDH’s
Course Materials

• QC/QA Asphalt Concrete Training Manual

• Standard Specifications for Roads and Bridges (2015 Edition) - Sections 320 and 322

• South Dakota DOT Materials Manual - Minimum Sample and Test Requirements (MSTR)

• Example Problems Packet
Course Agenda

• Sampling Hot Mix & Liquid Asphalt
• Binder Content
• Hydrated Lime
• Moisture in the Mix
• RAP Content
• Asphalt Draindown
• Correlation Testing
• Core Dryback
• Recertification Exam
Asphalt Concrete Production Control

- Preconstruction meeting by Contractor
- Line of authority shown for both QC and QA personnel
- Certified testing personnel
- Calibrated test equipment
- Quality Control plan
- Test strip or procedure for establishing roller pattern
Certification Requirements

• Testers must be QC/QA certified in SD and have proof of certification
• Testing equipment calibration records shall be available on National Highway System Projects, Gyratory internal angle calibrated

• Requirements: Materials Testing & Inspection Certification Program Manual
Certified Technicians

• The certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.
Mix Design Report

• Approved Mix Design Report
• Posted in both QC and QA lab
• Mix compaction temperatures
• Job Mix Formula
• Gyratory, Rice, & other Mix Design test results
• Manufactured Fines % or FAA
• Aggregate Composite % H₂O at SSD
• Aggregate composite Gsb and -#4 Gsb
Sampling Hot Mix

- Discussed in SD 312 and 313
- Stratified random number to get sampling location
- QC/QA sampling is from the windrow in front of the paver
- Use a square bottom shovel
  - Remove and discard approximately top 1 foot of windrow
  - Remove and discard outside edge to create a vertical face
  - Sample from vertical face into alternating buckets
Liquid Asphalt Samples

• PG Grades, sampled by contractor, witnessed by DOT, inline between storage tank and dryer drum, Frequency once per 200 ton, Daily oil cutoff from tank stick, (SD 314), Spot check on asphalt binder during the day, Maintain quantities of PG asphalt used

• Asphalt Emulsions and Cutbacks, sampled once per 100 ton, DOT, shot records and quantities used

• Materials Manual MSTR and Section 2 Training Manual
Binder Content

• Asphalt binder sample
  – In-line between storage tank and mix plant
  – One sample per 200 ton

• Asphalt binder content

• Daily cutoff (SD 314)
  – Tank stick
  – Form DOT-89
  – Problem
Problem #1
Asphalt Binder Content (SD 314)

Complete the DOT-89 form below. What is the Job Mix Formula Tolerance? _____

TANK METHOD

A. Beginning Specific Gravity of Bitumen @ 60°F
   1.035

B. Beginning Weight Per Gallon @ 60°F
   8.630

C. Temperature of Bitumen in Tank When Check Starts
   295*

D. Weight Per Gallon of Bitumen at Temperature

E. Gallons in Tank When Check Starts (calibrated stick)
   29272
   Gallons at Start (at start of tank use)

f. Weight of Bitumen in Tank (start check) (D x E / 2000)

G. Weight of Bitumen Added to Tank(s)

H. Temperature of Bitumen in Tank When Check Ends
   295*

I. Gallons in Tank When Check Ends (calibrated stick)
   29094

J. Ending Specific Gravity of Bitumen @ 60°F
   1.035

K. Ending Weight Per Gallon @ 60°F
   8.630

L. Weight Per Gallon at Temperature

M. Weight of Bitumen in Tank (end check) (I x L / 2000)
   Left in Storage (at end of tank use)

N. Weight of Bitumen Used (F + G - M)

O. Weight of Mix Produced (Tons)

P. Percent Bitumen in Mix (N / O x 100)

*Temp. Correction Factor Chart in SD 314

Summary of Mix Produced

<table>
<thead>
<tr>
<th></th>
<th>Load #</th>
<th>Invoice #</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Road</td>
<td>1</td>
<td>10007</td>
<td>26.80</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10009</td>
<td>26.47</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10012</td>
<td>33.79</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10017</td>
<td>40.64</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10019</td>
<td>25.65</td>
</tr>
</tbody>
</table>

Plant Waste: 0.0 Tons
Road Waste: 0.0 Tons
To Others: 0.0 Tons
Produced: 3707.24 Tons
Problem #1 - Answer
Asphalt Binder Content (SD314)

• D. Weight Per Gallon of Bitumen at Temperature

\[ = 8.630 \times 0.9204 \text{ (Temp. Correction Factor)} = 7.943 \]

• f. Weight of Bitumen in Tank (start check)

\[ = D \times \frac{E}{2000} = 7.943 \times \left(\frac{29272}{2000}\right) = 116.25 \]

• G. Weight of Bitumen Added to Tank(s)

Add Loads together → 26.80 + 26.47 + 33.79 + 40.64 + 25.65 = 153.35

• L. Weight Per Gallon at Temperature

\[ = 8.630 \times 0.9204 \text{ (Temp. Correction Factor)} = 7.943 \]
Problem #1 - Answer
Asphalt Binder Content (SD314)

M. Weight of Bitumen in Tank (end check)

\[ = L \times \frac{I}{2000} = 7.943 \times \left(\frac{29094}{2000}\right) = 115.55 \]

N. Weight of Bitumen Used

\[ = f + G - M = 116.25 + 153.35 - 115.55 = 154.05 \]

O. Weight of Mix Produced (Tons)

- From Summary of Mix Produced = 3707.24 Tons

P. Percent Bitumen in Mix

\[ = \left(\frac{N}{O}\right) \times 100 = \left(\frac{154.05}{3707.24}\right) \times 100 = 4.16 \% \]

Percent used by Test: 4.2 %
**Problem #1 - Answer**

Asphalt Binder Content (SD 314)

Complete the DOT-89 form below. What is the Job Mix Formula Tolerance? \( \pm 0.3 \)

<table>
<thead>
<tr>
<th>TANK METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Beginning Specific Gravity of Bitumen @ 60°F</td>
</tr>
<tr>
<td>B. Beginning Weight Per Gallon @ 60°F</td>
</tr>
<tr>
<td>C. Temperature of Bitumen in Tank When Check Starts</td>
</tr>
<tr>
<td>D. Weight Per Gallon of Bitumen at Temperature</td>
</tr>
<tr>
<td>E. Gallons in Tank When Check Starts (calibrated stick)</td>
</tr>
<tr>
<td>F. Weight of Bitumen in Tank (start check) (D x E / 2000)</td>
</tr>
<tr>
<td>G. Weight of Bitumen Added to Tank(s)</td>
</tr>
<tr>
<td>H. Temperature of Bitumen in Tank When Check Ends</td>
</tr>
<tr>
<td>I. Gallons in Tank When Check Ends (calibrated stick)</td>
</tr>
<tr>
<td>J. Ending Specific Gravity of Bitumen @ 60°F</td>
</tr>
<tr>
<td>K. Ending Weight Per Gallon @ 60°F</td>
</tr>
<tr>
<td>L. Weight Per Gallon at Temperature</td>
</tr>
<tr>
<td>M. Weight of Bitumen in Tank (end check) (I x L / 2000)</td>
</tr>
<tr>
<td>N. Weight of Bitumen Used (F + G - M)</td>
</tr>
<tr>
<td>O. Weight of Mix Produced (Tons)</td>
</tr>
<tr>
<td>P. Percent Bitumen in Mix (N / O x 100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G.</th>
<th>Load #</th>
<th>Invoice #</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>10007</td>
<td>26.80</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>10009</td>
<td>26.47</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>10012</td>
<td>33.79</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>10017</td>
<td>40.64</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>10019</td>
<td>25.65</td>
</tr>
</tbody>
</table>

*Temp. Correction Factor Chart in SD 314*

**Summary of Mix Produced**

<table>
<thead>
<tr>
<th></th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Road</td>
<td>3707.24</td>
</tr>
<tr>
<td>Plant Waste</td>
<td>0.0</td>
</tr>
<tr>
<td>Road Waste</td>
<td>0.0</td>
</tr>
<tr>
<td>To Others</td>
<td>0.0</td>
</tr>
<tr>
<td>Produced</td>
<td>3707.24</td>
</tr>
</tbody>
</table>
Hydrated Lime

- One sample per 750 tons, DOT
- Covered by certified lime plant if furnished by Pete Lien and Sons RC, sampled by DOT Central Lab on random basis
- Lime cutoff form DOT-33Q
- Specification allows Contractor to add 1.00% hydrated lime to mix and not have to verify the Tensile Strength Ratio (TSR), min. 80 required, for all levels.
Enclosed Pug Mill
Enclosed Pug Mill
Load Cells for Weighing Lime
Issues
Releasing lime into the air
Hydrated Lime

• Specification requires Contractor to add hydrated lime to aggregate containing a minimum moisture content of 1.0% above the saturated surface dry (SSD) condition of the aggregate as noted on the approved job mix formula.

• Problem
Problem #2
Hydrated Lime

Complete the DOT-33Q form below. What is the Job Mix Formula Tolerance? _____

<table>
<thead>
<tr>
<th><strong>TANK METHOD</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Weight of Lime in Tank at Start (Tons)</td>
</tr>
<tr>
<td>B. Weight of Lime Added to Tank (Tons)</td>
</tr>
<tr>
<td>C. Weight of Lime in Tank at End (Tons)</td>
</tr>
<tr>
<td>D. Weight of Lime Used (A + B - C) (Tons)</td>
</tr>
<tr>
<td>E. Weight of Mix Produced (Tons)</td>
</tr>
<tr>
<td>F. Percent of Lime in Mix (D / E x 100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Load #</strong></th>
<th><strong>Invoice #</strong></th>
<th><strong>Tons</strong></th>
<th><strong>Summary of Mix Produced</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5552</td>
<td>34.90</td>
<td>To Road 3707.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plant Waste 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Road Waste 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>To Others 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Produced 3707.24</td>
</tr>
</tbody>
</table>
Problem #2 - Answer

Hydrated Lime

Complete the DOT-33Q form below. What is the Job Mix Formula Tolerance? ± 0.10

<table>
<thead>
<tr>
<th>B. Load #</th>
<th>Invoice #</th>
<th>Tons</th>
<th>Summary of Mix Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>34.90</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>To Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3707.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plant Waste</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
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<td>Road Waste</td>
</tr>
<tr>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>To Others</td>
</tr>
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<td></td>
<td>0.0</td>
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<td></td>
<td></td>
<td></td>
<td>Produced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3707.24</td>
</tr>
</tbody>
</table>
Moisture in the Mix
SD 305

• One sample per 10,000 tons of hot mix, DOT sampled from paver area
• 1,500 to 3,000 gram sample
• (SD 305)
• Problem
**Problem #3**  
Moisture in the Mix

Complete the calculations below. What is the max % moisture allowed? ____

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Container Number:</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>B. Weight of container and cover (g):</strong></td>
<td>222.3</td>
</tr>
<tr>
<td><strong>C. Weight of container, cover and sample (g):</strong></td>
<td>1723.7</td>
</tr>
<tr>
<td><strong>D. Apparent dry weight (g):</strong></td>
<td>(C – B)</td>
</tr>
<tr>
<td><strong>E. Actual dry weight (g):</strong></td>
<td>(J – B)</td>
</tr>
<tr>
<td><strong>F. Moisture in material (g):</strong></td>
<td>(D – E)</td>
</tr>
<tr>
<td><strong>G. % Moisture in the Mix:</strong></td>
<td>((F / E) \times 100)</td>
</tr>
</tbody>
</table>

**DRYING WEIGH BACK AREA (H)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 PM</td>
<td>1722.1</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>1721.9</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>1721.8</td>
</tr>
</tbody>
</table>

**J.**  
**Weight of material and pan:** 1721.8

**Percent Moisture in the Mix:**  
Spec:  
____
Problem #3 - Answer

Moisture in the Mix

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Container Number:</td>
<td>1</td>
</tr>
<tr>
<td>B. Weight of container and cover (g):</td>
<td>222.3</td>
</tr>
<tr>
<td>C. Weight of container, cover and sample (g):</td>
<td>1723.7</td>
</tr>
<tr>
<td>D. Apparent dry weight (g): ( (C - B) )</td>
<td>1501.4</td>
</tr>
<tr>
<td>E. Actual dry weight (g): ( (J - B) )</td>
<td>1499.5</td>
</tr>
<tr>
<td>F. Moisture in material (g): ( (D - E) )</td>
<td>1.9</td>
</tr>
<tr>
<td>G. % Moisture in the Mix: ( \frac{F}{E} \times 100 )</td>
<td>0.13</td>
</tr>
</tbody>
</table>

\[
D = 1723.7 - 222.3 = 1501.4 \\
E = 1721.8 - 222.3 = 1499.5 \\
F = 1501.4 - 1499.5 = 1.9 \\
G = \left( \frac{1.9}{1499.5} \right) \times 100 = 0.13
\]

Drying Weigh Back Area (H)

<table>
<thead>
<tr>
<th>Time</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 PM</td>
<td>1722.1</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>1721.9</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>1721.8</td>
</tr>
</tbody>
</table>

J. Weight of material and pan: 1721.8

Percent Moisture in the Mix: 0.1 %

Spec: 0.3% max
Impermeable Mix + Heat + Moisture
Warm Mix – Foaming Device
RAP Content
Q_R or HR mixes

• RAP percentage
  – Daily cutoff
  – Requirements for scales?
    • 0.5% accuracy based on the net weight
  – Belt scales and moisture contents
  – Form DOT-93
  – Problem
**Problem #4**  
**RAP Content**

Complete the DOT-93 form below. Use the RAP equation sheet found in the Problems Packet. What is the Job Mix Formula Tolerance? _____

<table>
<thead>
<tr>
<th>WEIGH TICKET ENTRIES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Total of hot mix produced by tickets (tons)</td>
<td>3707.24</td>
</tr>
<tr>
<td>B. Moisture in the mix percentage (most recent one tested)</td>
<td>0.13</td>
</tr>
<tr>
<td>C. Moisture in the mix (tons)</td>
<td></td>
</tr>
<tr>
<td>D. Total dry amount of hot mix produce for the day (tons)</td>
<td></td>
</tr>
<tr>
<td>E. Added binder percentage by cutoff (DOT-89)</td>
<td>4.20</td>
</tr>
<tr>
<td>F. Total amount of added binder (tons)</td>
<td></td>
</tr>
<tr>
<td>G. Added lime percentage by cutoff (DOT-33Q)</td>
<td>0.99</td>
</tr>
<tr>
<td>H. Total amount of added lime (tons)</td>
<td></td>
</tr>
<tr>
<td>I. Total dry Virgin MA and RAP from tickets &amp; cutoffs (tons)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEIGH BRIDGE ENTRIES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>J. Weight of Virgin MA from weight bridge totalizer (tons)</td>
<td>2761.1</td>
</tr>
<tr>
<td>K. Percentage moisture in Virgin MA</td>
<td>3.9</td>
</tr>
<tr>
<td>L. Weight of water in Virgin MA (tons)</td>
<td></td>
</tr>
<tr>
<td>M. Weight of dry Virgin MA (tons)</td>
<td></td>
</tr>
<tr>
<td>N. Weight of RAP from weigh bridge totalizer (tons)</td>
<td>830.2</td>
</tr>
<tr>
<td>O. Percent moisture in RAP</td>
<td>0.2</td>
</tr>
<tr>
<td>P. Weight of water in the RAP mixture (tons)</td>
<td></td>
</tr>
<tr>
<td>Q. Weight of dry RAP from weigh bridge totalizer (tons)</td>
<td></td>
</tr>
<tr>
<td>R. Total dry Virgin MA and RAP from weigh bridges (tons)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RAP PERCENTAGES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Percentage of RAP based on weigh bridges</td>
<td></td>
</tr>
<tr>
<td>T. Percentage of RAP based on weigh tickets</td>
<td></td>
</tr>
<tr>
<td>U. % difference between scale tickets and weigh bridges</td>
<td></td>
</tr>
</tbody>
</table>
C. Moisture in the mix (tons):
\[
\frac{A \times \left( \frac{B}{100} \right)}{1 + \left( \frac{B}{100} \right)} = \frac{3707.24 \times \left( \frac{0.13}{100} \right)}{1 + \left( \frac{0.13}{100} \right)} = 4.81
\]

D. Total dry amount of hot mix produced for the day (tons):
\[
D = A - C = 3707.24 - 4.81 = 3702.43
\]

F. Total amount of added binder (tons):
\[
F = A \times \left( \frac{E}{100} \right) = 3707.24 \times \left( \frac{4.20}{100} \right) = 155.70
\]

H. Total amount of added lime (tons):
\[
H = A \times \left( \frac{G}{100} \right) = 3707.24 \times \left( \frac{0.99}{100} \right) = 36.70
\]

I. Total dry Virgin MA and RAP from tickets & cutoffs (tons):
\[
I = D - (F + H) = 3702.43 - (155.70 + 36.70) = 3510.03
\]
WEIGH BRIDGE ENTRIES

L. Weight of water in Virgin MA (tons):
\[
J \times \frac{K}{1 + \left(\frac{K}{100}\right)} = \frac{2761.1 \times \left(\frac{3.9}{100}\right)}{1 + \left(\frac{3.9}{100}\right)} = 103.64
\]

M. Weight of dry Virgin MA (tons):
\[
M = J - L = 2761.1 - 103.64 = 2657.46
\]

P. Weight of water in the RAP mix (tons):
\[
N \times \frac{0}{1 + \left(\frac{0}{100}\right)} = \frac{830.2 \times \left(\frac{0.2}{100}\right)}{1 + \left(\frac{0.2}{100}\right)} = 1.66
\]

Q. Weight of dry RAP from weight bridge totalizer (tons):
\[
Q = N - P = 830.2 - 1.66 = 828.54
\]

R. Total dry Virgin MA and RAP from weigh bridges (tons):
\[
R = M + Q = 2657.46 + 828.54 = 3486.0
\]
RAP PERCENTAGES

S. Percentage of RAP based on weigh bridges:

\[ S = \left( \frac{Q}{R} \right) \times 100 = \left( \frac{828.54}{3486.0} \right) \times 100 = 23.8\% \]

T. Percentage of RAP based on weigh tickets:

\[ T = \left( \frac{Q}{I} \right) \times 100 = \left( \frac{828.54}{3510.03} \right) \times 100 = 23.6\% \]

U. % difference between scale tickets and weigh bridges:

\[ U = \left( \frac{I - R}{I} \right) \times 100 = \left( \frac{3510.03 - 3486.0}{3510.03} \right) \times 100 = 0.68\% \]

Percent RAP by Test (weigh bridges) = 24 %

JMF tolerance = \pm 5
Problem #4 - Answer

RAP Content

What is the Job Mix Formula Tolerance?  ± 5 %
Asphalt Draindown Procedure
SD 306

• Used on Class S or SMA
• Determines the amount of draindown material in an uncompacted bituminous paving mixture
• Problem
Problem #5

Draindown

Calculate the draindown percentage on the DOT-91 form below.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Asphalt Draindown Worksheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>File No.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>COUNTY</th>
<th>PCN</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field #</th>
<th>Date Sampled</th>
<th>Date Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sampled By</th>
<th>Tested By</th>
<th>Checked By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MixType</th>
<th>Class</th>
<th>Asphalt Cement</th>
<th>Cellulose Fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight of test sample</th>
<th>1327.4 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of container empty</td>
<td>52.3 grams</td>
</tr>
<tr>
<td>Draindown</td>
<td>≤ 0.3%</td>
</tr>
<tr>
<td>Temperature of test sample</td>
<td>300 °F</td>
</tr>
</tbody>
</table>
\[
\left( \frac{(53.1 - 52.3)}{1327.4} \right) \times 100 = 0.06 = 0.1\% 
\]
Hot Mix Correlation Testing

• Sample supplied by contractor, may be plant produced if spot leveling,
  Specifications

• Gyratory (SD 318)

• Theoretical Max Sp. Gr., Rice (SD 312)

• Air Void calculation on form DOT-69
Bulk Specific Gravity Reheat Correlation

- 1<sup>st</sup> subplot of material
- Cool to room temperature, reheat to compaction temperature
- Used for IA tolerances and if QC vs. QA correlation problems occur
- Shows aggregate and asphalt mixture absorption rates
Approximate Test Size and Tests Needed

- Bulk Specific Gravity of Compacted mix, Gyratory specimens (SD 318), 2 made @ N_{des} at 115 ± 5 mm, approximately 4500 to 4800 grams
- If gyratory specimen doesn’t compact to 115 ± 5 mm, use the following equation:

\[
\frac{115 \times \text{[Actual wt. of specimen (g)]}}{\text{[Actual height of specimen]}} = \text{amount needed for correct height}
\]

\[
(115 \times 4505.6) / 110.5 = 4689.1 \text{ grams}
\]

- Theoretical maximum specific gravity of uncompacted mix, Rice, (SD 312)
  - ¼” nominal mix → 2,000 grams min.
  - ½” nominal mix → 1,500 grams min.
Problem #6
DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q2R Mix.

Use the equation sheet in the Problems Packet.
Problem #6
DOT-86
Gyratory Worksheet

\[
dust\ (\#200) + \text{lime} = 3.7 + 0.99 = 4.7
\]

**Spec. A:** Gmb measured \( \frac{b}{(d - c)} = \frac{4738.1}{(4741.8 - 2724.9)} = 2.349 \)

**Spec. B:** Gmb measured \( \frac{b}{(d - c)} = \frac{4746.5}{(4749.6 - 2729.9)} = 2.350 \)

**Spec. A:** Gmb calculated \( \frac{(Gmb\,\text{meas} \times \text{height} @ Ndes)}{(\text{height} @ Nini)} = \frac{(2.349 \times 115.7)}{124.2} = 2.188 \)

**Spec. B:** Gmb calculated \( \frac{(Gmb\,\text{meas} \times \text{height} @ Ndes)}{(\text{height} @ Nini)} = \frac{(2.350 \times 115.9)}{124.6} = 2.186 \)

Average Gmb @ Ninital \( = \frac{(2.188 + 2.186)}{2} = 2.187 \)

Average Gmb @ Ndesign \( = \frac{(2.349 + 2.350)}{2} = 2.350 \)

**No. of gyrations**
- Spec. Book Sect. 322 (Q2R – Table G)
  - \( N_{\text{initial}} = 6 \)
  - \( N_{\text{design}} = 50 \)
  - \( N_{\text{max}} = 75 \)
Problem #6
DOT-86
Gyratory Worksheet

Rice SpGr = \[ \frac{\text{wt. of sample in air}}{(\text{wt. of sample in air}) + (\text{wt. of canister} + H_2O) - (\text{wt. of canister} + H_2O + \text{sample})} \] \times \text{Corr. Factor}

Gmm #1 = \[ \left[ \frac{1505.3}{(1505.3 + 1275.3) - 2166.6} \right] \times 1.0001 = 2.452 \]

Gmm #2 = \[ \left[ \frac{1523.9}{(1523.9 + 1275.3) - 2177.5} \right] \times 1.0001 = 2.451 \]

Average Max SpGr (Gmm) = \( \frac{(2.452 + 2.451)}{2} \) = 2.452

% of Rice SpGr (Gmm) @ Ninitial = \( \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.187}{2.452} \times 100 = 89.2\% \)

% of Rice SpGr (Gmm) @ Ndesign = \( \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.350}{2.452} \times 100 = 95.8\% \)
Problem #6
DOT-86
Gyratory Worksheet

\% Air Voids (Va) = \left( \frac{Gmm - Gmb}{Gmm} \right) \times 100 = \left( \frac{2.452 - 2.350}{2.452} \right) \times 100 = 4.2\%

Ps = 100 - Pb = 100 - 5.4 = 94.6\%

\% VMA = 100 - \left( \frac{Gmb \times Ps}{Gsb} \right) = 100 - \left( \frac{2.350 \times 94.6}{2.609} \right) = 14.8\%

\% VFA = \left( \frac{VMA - Va}{VMA} \right) \times 100 = \left( \frac{14.8 - 4.2}{14.8} \right) \times 100 = 72 \% (\text{whole percent})

Gse = \frac{100 - Pb}{\left( \frac{100}{Gmm} \right) - \left( \frac{Pb}{Gb} \right)} = \frac{100 - 5.4}{\left( \frac{100}{2.452} \right) - \left( \frac{5.4}{1.035} \right)} = 2.660
Problem #6

DOT-86
Gyratory Worksheet

\[ \text{PPPGM} = 100 \times \left( \frac{Gse - Gsb}{Gse \times Gsb} \right) \times Gb = 100 \times \left( \frac{2.660 - 2.609}{2.660 \times 2.609} \right) \times 1.035 = 0.76 \% \]

\[ \text{PPPGL} = \frac{Pb}{\text{PBa}} \times 100 = 5.4 - \left( \frac{0.76 \times 94.6}{100} \right) = 4.7 \% \]

Dust to Binder Ratio \[ = \left( \frac{\text{dust} - \#200 + \text{lime}}{Pbe} \right) = \left( \frac{4.7}{4.7} \right) = 1.0 \]

Specs: Spec Book - Sect. 322 (Q2R mix)
- TABLE L (% Air Voids) \rightarrow 4.0\% \pm 1.0\%
- TABLE I (% VMA) \rightarrow *minimum 13.5\% during production
- TABLE J (% VFA) \rightarrow *evaluated @ mix design only
- Dust to Binder Ratio \rightarrow 0.6 to 1.4 -or- 0.8 to 1.6 (depends on gradation @ mix design)
Problem #6

Answer

Q2R Mix

<table>
<thead>
<tr>
<th>Mix Temp</th>
<th>275</th>
</tr>
</thead>
</table>

| % binder Pb | 5.4 | N initial | 6 |
| Gsb        | 2.609 | N design | 50 |
| binder Gb  | 1.035 | N max | 75 |
| dust (- #200) | 3.70 | | |
| lime  | 0.99 | | |
| dust(-#200) + lime | 4.7 | | |

<table>
<thead>
<tr>
<th>Spec. A (Ndes)</th>
<th>Spec. B (Ndes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ N ini</td>
<td>@ N des</td>
</tr>
<tr>
<td>124.2</td>
<td>115.7</td>
</tr>
<tr>
<td>2.349</td>
<td>2.350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gmm #1</th>
<th>Gmm #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of sample in air</td>
<td>1505.3</td>
</tr>
<tr>
<td>Weight of canister + H₂O</td>
<td>1275.3</td>
</tr>
<tr>
<td>Weight of canister + H₂O + sample</td>
<td>2166.6</td>
</tr>
<tr>
<td>Temperature of water</td>
<td>24.4</td>
</tr>
<tr>
<td>H₂O correction factor</td>
<td>1.0001</td>
</tr>
<tr>
<td>Rice SpGr (Gmm)</td>
<td>2.452</td>
</tr>
</tbody>
</table>

Average Max SpGr (Gmm) | 2.452 |

<table>
<thead>
<tr>
<th>Average Gmb</th>
<th>N initial</th>
<th>N design</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.187</td>
<td>2.350</td>
<td></td>
</tr>
<tr>
<td>% of Rice SpGr (Gmm)</td>
<td>89.2</td>
<td>95.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Air Voids (Va)</th>
<th>4.2</th>
<th>% VMA</th>
<th>14.8</th>
<th>% VFA</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specs:</td>
<td>4.0 ± 1.0</td>
<td>*13.5 min</td>
<td>*mix design only</td>
<td>Binder Ratio</td>
<td>1.0</td>
</tr>
<tr>
<td>Dust to</td>
<td>0.6 – 1.4</td>
<td>*-or-</td>
<td>0.8 – 1.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
QC/QA In Place Pavement Density

- 2 samples per 1000 tons, random location determined by DOT, (SD 315)
- No buffer zone
- Cores taken by contractor and sawed
- Inspected for damage to cores
- Tested by DOT, evaluated statistically for specification
Core Dryback Procedure

• Test procedure *(SD 315)*
• Get added moisture from coring process out of cores
• Form DOT-8, transfer info to the DOT-42Q
• *PROBLEM*
Problem #7
Core Dryback

Complete the DOT-42-Q form below.

### Theoretical Maximum Specific Gravity

<table>
<thead>
<tr>
<th>Sublot No.</th>
<th>Max. Sp. Gr.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.447</td>
<td>2.452</td>
<td>2.452</td>
<td>2.450</td>
<td>2.441</td>
</tr>
</tbody>
</table>

Lot Average Maximum Specific Gravity (Standard) ______________

### In-Place Density Measurement

Percent of Standard = \[
\frac{\text{Core Bulk Specific Gravity}}{\text{Lot Average Maximum Specific Gravity}}\] x 100

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Sublot</th>
<th>Height</th>
<th>Rand Nbr</th>
<th>Cumulative Tonnage</th>
<th>Station for Core</th>
<th>Rand Nbr</th>
<th>Paving Width</th>
<th>Distance from C/L</th>
<th>Actual Dry Weight</th>
<th>Weight in Water</th>
<th>SSD Weight</th>
<th>Reheat Correction Factor</th>
<th>Core Bulk Specific Gravity</th>
<th>Percent of Standard</th>
<th>Percent of Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>2.00</td>
<td>.61</td>
<td>305</td>
<td>165+52</td>
<td>.28</td>
<td>11</td>
<td>3.1</td>
<td>LT</td>
<td>1340.3</td>
<td>757.7</td>
<td>1351.7</td>
<td>XX</td>
<td>2.256</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>1 B</td>
<td>2.25</td>
<td>.99</td>
<td>995</td>
<td>123+71</td>
<td>.65</td>
<td>11</td>
<td>7.2</td>
<td>LT</td>
<td>1430.2</td>
<td>808.0</td>
<td>1440.2</td>
<td>XX</td>
<td>2.262</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>2 A</td>
<td>2.13</td>
<td>.06</td>
<td>1,030</td>
<td>121+59</td>
<td>.17</td>
<td>11</td>
<td>1.9</td>
<td>LT</td>
<td>1308.2</td>
<td>739.8</td>
<td>1314.7</td>
<td>XX</td>
<td>2.276</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>2 B</td>
<td>2.50</td>
<td>.65</td>
<td>1,825</td>
<td>73+42</td>
<td>.18</td>
<td>11</td>
<td>2.0</td>
<td>LT</td>
<td>1530.2</td>
<td>860.2</td>
<td>1541.3</td>
<td>XX</td>
<td>2.247</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>3 A</td>
<td>2.13</td>
<td>.01</td>
<td>2,005</td>
<td>82+51</td>
<td>.82</td>
<td>11</td>
<td>9.0</td>
<td>LT</td>
<td>1312.5</td>
<td>739.0</td>
<td>1321.8</td>
<td>XX</td>
<td>2.252</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>3 B</td>
<td>2.25</td>
<td>.32</td>
<td>2,660</td>
<td>22+62</td>
<td>.89</td>
<td>11</td>
<td>7.6</td>
<td>LT</td>
<td>1386.8</td>
<td>760.6</td>
<td>1397.0</td>
<td>XX</td>
<td>2.250</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>4 A</td>
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<td>.00</td>
<td>3,000</td>
<td>2+22</td>
<td>.26</td>
<td>11</td>
<td>2.9</td>
<td>LT</td>
<td>1504.5</td>
<td>851.9</td>
<td>1510.3</td>
<td>XX</td>
<td>2.285</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>4 B</td>
<td>1.75</td>
<td>.84</td>
<td>3,920</td>
<td>143+72</td>
<td>.90</td>
<td>11</td>
<td>9.9</td>
<td>RT</td>
<td>1197.8</td>
<td>679.8</td>
<td>1202.2</td>
<td>XX</td>
<td>2.293</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>5 A</td>
<td>2.38</td>
<td>.36</td>
<td>4,180</td>
<td>127+23</td>
<td>.10</td>
<td>11</td>
<td>1.1</td>
<td>RT</td>
<td>1441.7</td>
<td>802.7</td>
<td>1449.0</td>
<td>XX</td>
<td>2.231</td>
<td>XX</td>
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<tr>
<td>5 B</td>
<td>2.25</td>
<td>.07</td>
<td>4,535</td>
<td>104+71</td>
<td>.59</td>
<td>11</td>
<td>6.5</td>
<td>RT</td>
<td>1463.7</td>
<td>832.4</td>
<td>1467.9</td>
<td>XX</td>
<td>2.303</td>
<td>XX</td>
<td>XX</td>
</tr>
</tbody>
</table>

Percent Density: _______
Problem #7 - Answer

Core Dryback

Lot Avg. Max SpGr (Standard) = \( \frac{2.447 + 2.452 + 2.452 + 2.450 + 2.441}{5} \) = 2.448

Percent of Standard = \( \left( \frac{\text{Core Bulk Specific Gravity}}{\text{Lot Avg. Max SpGr}} \right) \times 100 \) (round to the hundredth)

Average Percent Standard = \( \frac{\% \text{ of Standard A} + \% \text{ of Standard B}}{2} \) (round to the tenth)
Problem #7 - Answer
Core Dryback

Complete the DOT-42-Q form below.

### Theoretical Maximum Specific Gravity

<table>
<thead>
<tr>
<th>Sublot No.</th>
<th>Max. Sp. Gr.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.447</td>
<td>2.452</td>
<td>2.452</td>
<td>2.450</td>
<td>2.441</td>
<td></td>
</tr>
</tbody>
</table>

Lot Average Maximum Specific Gravity (Standard) **2.448**

### In-Place Density Measurement

Percent of Standard = \[
\frac{\text{Core Bulk Specific Gravity}}{\text{Lot Average Maximum Specific Gravity}} \times 100
\]

<table>
<thead>
<tr>
<th>Core Sublot</th>
<th>Height</th>
<th>Rand Nbr</th>
<th>Cumulative Tonnage</th>
<th>Station for Core</th>
<th>Rand Nbr</th>
<th>Paving Width</th>
<th>Distance from C/L</th>
<th>Actual Dry Weight</th>
<th>Weight in Water</th>
<th>SSD Weight</th>
<th>Reheat Correction Factor</th>
<th>Core Bulk Specific Gravity</th>
<th>Percent of Standard</th>
<th>Average Percent Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>2.00</td>
<td>.61</td>
<td>305</td>
<td>165+52</td>
<td>.28</td>
<td>11</td>
<td>LT</td>
<td>1340.3</td>
<td>757.7</td>
<td>1351.7</td>
<td>2.256</td>
<td>92.16</td>
<td>92.3</td>
<td></td>
</tr>
<tr>
<td>1 B</td>
<td>2.25</td>
<td>.99</td>
<td>995</td>
<td>123+71</td>
<td>.65</td>
<td>11</td>
<td>LT</td>
<td>1430.2</td>
<td>808.0</td>
<td>1440.2</td>
<td>2.262</td>
<td>92.40</td>
<td>92.97</td>
<td></td>
</tr>
<tr>
<td>2 A</td>
<td>2.13</td>
<td>.06</td>
<td>1,030</td>
<td>121+59</td>
<td>.17</td>
<td>11</td>
<td>LT</td>
<td>1308.2</td>
<td>739.8</td>
<td>1314.7</td>
<td>2.276</td>
<td>92.0</td>
<td>91.79</td>
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</tr>
<tr>
<td>2 B</td>
<td>2.50</td>
<td>.65</td>
<td>1,825</td>
<td>734+42</td>
<td>.18</td>
<td>11</td>
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<td>1530.2</td>
<td>860.2</td>
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<td>2.247</td>
<td>91.99</td>
<td>91.91</td>
<td>92.4</td>
</tr>
<tr>
<td>3 A</td>
<td>2.13</td>
<td>.01</td>
<td>2,005</td>
<td>82+51</td>
<td>.82</td>
<td>11</td>
<td>LT</td>
<td>1312.5</td>
<td>739.0</td>
<td>1321.8</td>
<td>2.252</td>
<td>92.0</td>
<td>91.99</td>
<td></td>
</tr>
<tr>
<td>3 B</td>
<td>2.25</td>
<td>.32</td>
<td>2,660</td>
<td>22+62</td>
<td>.89</td>
<td>11</td>
<td>LT</td>
<td>1386.8</td>
<td>760.6</td>
<td>1397.0</td>
<td>2.250</td>
<td>91.91</td>
<td>92.0</td>
<td></td>
</tr>
<tr>
<td>4 A</td>
<td>2.38</td>
<td>.00</td>
<td>3,000</td>
<td>2+22</td>
<td>.26</td>
<td>11</td>
<td>LT</td>
<td>1504.5</td>
<td>851.9</td>
<td>1510.3</td>
<td>2.285</td>
<td>93.34</td>
<td>93.67</td>
<td>93.5</td>
</tr>
<tr>
<td>4 B</td>
<td>1.75</td>
<td>.84</td>
<td>3,920</td>
<td>143+72</td>
<td>.90</td>
<td>11</td>
<td>RT</td>
<td>1197.8</td>
<td>679.8</td>
<td>1202.2</td>
<td>2.293</td>
<td>93.67</td>
<td>93.67</td>
<td>93.6</td>
</tr>
<tr>
<td>5 A</td>
<td>2.38</td>
<td>.36</td>
<td>4,180</td>
<td>127+23</td>
<td>.10</td>
<td>11</td>
<td>RT</td>
<td>1441.7</td>
<td>802.7</td>
<td>1449.0</td>
<td>2.231</td>
<td>91.14</td>
<td>92.6</td>
<td></td>
</tr>
<tr>
<td>5 B</td>
<td>2.25</td>
<td>.07</td>
<td>4,535</td>
<td>104+71</td>
<td>.59</td>
<td>11</td>
<td>RT</td>
<td>1463.7</td>
<td>832.4</td>
<td>1467.9</td>
<td>2.303</td>
<td>94.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percent Density: **92.6**
In Place Pavement Density

- Random locations determined by DOT, (SD 311)
- Nuclear density gauge used
- Gauge calibrated to roadway cutouts (SD 307)
- Form DOT-42
Use of Contractor Tests

• Statistic analysis using QC, QA, IA test results
• Similar/dissimilar (SD 317)
• F-test and t-test statistical evaluation
• Pay Factor
  ▪ 50% → Air Voids ($V_a$)
  ▪ 50% → In Place Density (% $G_{nm}$)
  ▪ 5% bonus opportunity
### F and t tests (Example)

<table>
<thead>
<tr>
<th></th>
<th>avg 2.446</th>
<th>2.347</th>
<th>4.04</th>
<th>avg 2.445</th>
<th>2.348</th>
<th>4.00</th>
<th>avg 2.447</th>
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Construction

- New tests and mix design procedures are in the Materials Manual, new Specification Book 2015, also at sddot.com
- Gyratory Control Projects (Q_R with RAP)
- M S & T, automated part of Construction Management System (CMS) test forms
- Ride Specification on most Projects
- Asphalt Pavement Analyzer (APA) used on most Projects with specification based on traffic level
Updates

• Intelligent Compaction
• Changes to RAP usage in specification from Research Project
• Warm Mix Asphalt specification from Research Project
• Low temperature cracking tests, Disk-Shaped Compact Tension Test (DCT) and Semi-Circular Bend Test (SCB) done in mix design lab
• Tack changes (increased rate by supplemental spec.)
• Rumble stripes or strips, edge line and centerline for safety
Recertification Exam

• Once the exam has started, you will have approximately 2 hours to complete the exam.

• The Exam is open book/notes (Standard Specifications for Roads and Bridges – 2015, QC/QA Asphalt Concrete Training Manual and the Materials Manual)

• A score of 70% or better is required to pass the exam.