Mix Design & Production Control Recertification

Quality Control / Quality Assurance

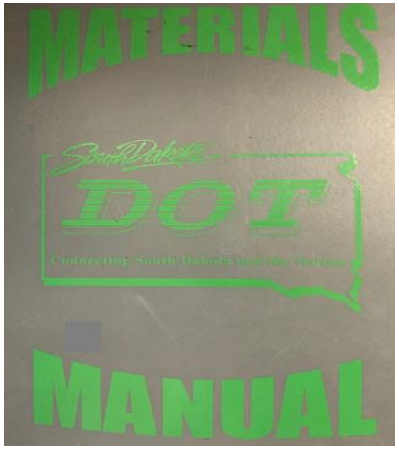
SD DEPARTMENT OF TRANSPORTATION

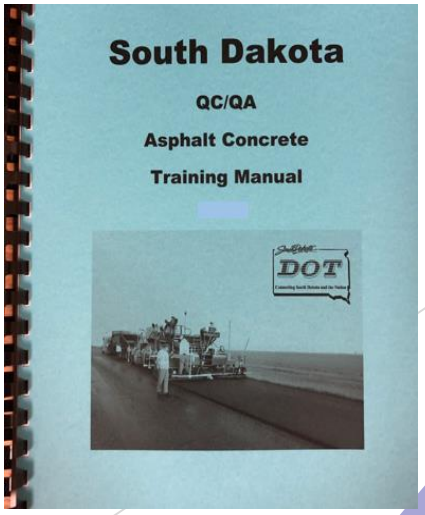
IMPORTANT

Recertification is only for individuals currently certified and actively participating on Asphalt Concrete Projects.

Course Materials

- QC/QA Asphalt Concrete Training Manual
- Standard Specifications for Roads and Bridges
  - Supplemental Specifications
- South Dakota DOT Materials Manual
  - Minimum Sample & Test Requirements





Course Agenda

- Specifications
- Aggregate Requirements
- Flat & Elongated Example
- Composites
- Mix Design Calculations
- Submittals
- SDDOT Verification
- Field Testing & Problems
- Recertification Exam

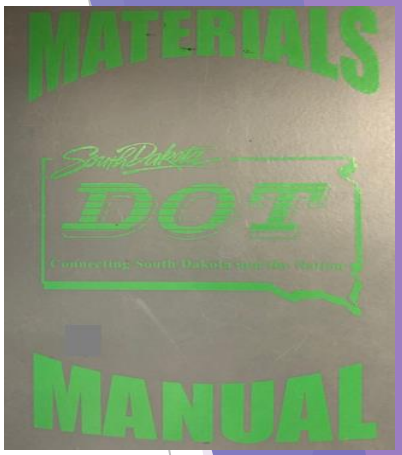
Contractor Design Requirements

- SD 319, SDDOT test procedures, and AASHTO and ASTM references
- Mix design must meet all SDDOT requirements and specifications (Special Provisions, Standard Specs, etc.)
- Furnish mix design including lab data and test results.
- Contractor must maintain calibration records for all lab testing equipment

Aggregate Requirements

- Get legal pit descriptions for all aggregate sources
- Quality tests completed on aggregate sources
- Use average stockpile gradation tests
- Determine proposed trial bin splits

Aggregate Tests Needed for Gyratory Control



- Fine Aggregate Angularity (SD 217)
- Sand Equivalent (SD 221)
- Lightweight Particles (SD 208 & SD 214)
- Crushed Particles (SD 211)
- Specific Gravity and Absorption of Aggregates (SD 209 & SD 210)
- LA Abrasion (SD 204)
- Sodium Sulfate Soundness Loss (5 cycles) (SD 220)
- Gradation (SD 202)
- Flat & Elongated Particles (SD 212)

Problem #1

Flat & Elongated (SD 212)

Given the following gradation, calculate the percent of flat and elongated particles.

Gradation	
Sieve Size	**Retained (g)**
3/4"	0.0
5/8"	0.0
1/2"	227.8
3/8"	696.9
1/4"	1219.8
#4	922.8

	A	B	C	D	E
Sieve Size	**Total Sample Weight on Sieve**	**Weight of Tested Portion** (100 pieces)	**Weight of Flat/Elongated Particles**	**% Flat/Elongated (Individual Sieve)**	**% Flat/Elongated Weighted Average**
3/4" to 1/2"		227.8	5.0		
1/2" to 3/8"		222.2	7.3		
3/8" to #4		61.1	3.0		
Total Sample Wt.		F			

Percent flat and elongated particles in the total sample (weighted average) rounded

Problem #1 - Answer

Flat & Elongated (SD 212)

Gradation	
Sieve Size	Retained (g)
3/4"	0.0
5/8"	0.0
1/2"	227.8
3/8"	696.9
1/4"	1219.8
#4	922.8

Add together

	A	B	C	D	E
Sieve Size	Total Sample Weight on Sieve	Weight of Tested Portion (100 pieces)	Weight of Flat/Elongated Particles	% Flat/Elongated (Individual Sieve)	% Flat/Elongated Weighted Average
3/4" to 1/2"	227.8	227.8	5.0	2.2	0.2
1/2" to 3/8"	696.9	222.2	7.3	3.3	0.7
3/8" to #4	2142.6	61.1	3.0	4.9	3.4
Total Sample Wt.	3067.3	F			

Percent flat and elongated particles in the total sample (weighted average)		4.3
	rounded	4

- (F) $Total\ Sample\ Wt. = 227.8 + 696.9 + 2142.6 = 3067.3$
- (D) $\%\ F\&E\ (individual\ sieve) = \left(\frac{C}{B}\right) \times 100 = \left(\frac{5.0}{227.8}\right) \times 100 = 2.2$ (1/2")
- $\left(\frac{7.3}{222.2}\right) \times 100 = 3.3$ (3/8") $\left(\frac{3.0}{61.1}\right) \times 100 = 4.9$ (#4)
- (E) $\%\ F\&E\ (weighted\ avg) = \left(\frac{A}{F}\right) \times D = \left(\frac{227.8}{3067.3}\right) \times 2.2 = 0.2$ (1/2")
- $\left(\frac{696.9}{3067.3}\right) \times 3.3 = 0.7$ (3/8") $\left(\frac{2142.6}{3067.3}\right) \times 4.9 = 3.4$ (#4)
- $Total\ \%\ F\&E = 0.2 + 0.7 + 3.4 = 4.3 = 4$ (rounded)

Composite Mineral Aggregate Specification Requirements

- Vary by traffic level (Q1, Q2, Q3, Q4, Q5)
- With or without hydrated lime
- RAP if required
- Example Problem

Problem #2

- Q2R mix with 20% RAP to be added by weight of aggregate
- Solvent extraction test result of 6.50% binder in RAP
- 1.00% hydrated lime added by weight of total mix
- Aggregate bin splits
  - 30% Crushed Rock
  - 25% Crushed Fines
  - 30% Natural Fines
  - 15% Sand
- Prepare a 4750 gram batch with 4.5% added new binder by weight of total mix
- Determine amount of added new binder, lime, RAP, rock, crushed fines, natural fines and sand to be added for a gyratory specimen
- Also determine total binder, new (added) and old (RAP) %

Answer Problem #2

- 4750 grams total for gyratory specimen
  - (4750 x 4.5) / 100 = 213.8 grams (new binder by weight of total mix)
  - (4750 x 1.00) / 100 = 47.5 grams (hydrated lime by weight of total mix)
  - (47.5 + 213.8) = 261.3 grams
  - (4750 – 261.3) = 4488.7 grams (aggregate and RAP)
  - (4488.7 x 20) / 100 = 897.7 grams (RAP)
  - (4488.7 – 897.7) = 3591.0 grams (Virgin MA aggr.)

    -or- (4488.7 x 80) / 100 = 3591.0 grams (Virgin MA aggr.)
  - (3591.0 x 30) / 100 = 1077.3 grams (crushed rock)
  - (3591.0 x 25) / 100 = 897.8 grams (crushed fines)
  - (3591.0 x 30) / 100 = 1077.3 grams (natural fines)
  - (3591.0 x 15) / 100 = 538.7 grams (sand)

Answer Problem #2 (continued)

- Binder from RAP => (897.7 x 6.5) / 100 = 58.4 grams (old binder from RAP)
- 58.4 grams from RAP + 213.8 grams added binder = 272.2 grams (total binder)
- (272.2 / 4750) x 100 = 5.73% total binder in mix
- (58.4 / 272.2) x 100 = 21.45% old binder from RAP
- (213.8 / 272.2) x 100 = 78.55% new binder
  - This assumes all old binder is effective. Probably not the case, but effective amount is not able to be determined at this time and varies by mix design.

Specifications

- Gradation Control Points
- Flat & Elongated
  - Only a spec. at mix design
- Bin splits adjusted up to 5 percent to meet gradation and mix design requirements
- 92.0% to 97.0% In-place density for all levels
- Asphalt Pavement Analyzer (APA) specification on all mix designs
- Contractors and Consultants doing mix designs must participate in Round Robin testing (Sample Proficiency Program)

Mix Design Specifications
(Gyratory Control)

- Air Voids
  - 4.0% ± 1.0% (unless changed by plan note)
- Voids in the Mineral Aggregate (VMA)
  - Min. 14.5% at mix design, 13.5% during production
- Voids Filled with Asphalt (VFA)
  - at mix design only
- Densification at N_{ini} , N_{des} and N_{max}
  - N_{des} only in field for spec.
- Dust to Binder Ratio
  - Based on effective asphalt content
- Moisture Sensitivity (TSR ratio)
  - Min. 80 required on all mixes (Q1, Q2, Q3, Q4, Q5).
  - (only if 1.00% lime is not added)

Mixture Tests
(Gyratory Control)

- Density and Air Voids of Asphalt Concrete by Gyratory Compaction Method (SD 318)
- Densification at N_{ini} , N_{des} and N_{max}
- VMA calculation (SD 318)
- Dust to Binder Ratio
- Rice Test (SD 312)
- Moisture Sensitivity of Compacted Asphalt Concrete Paving Mixtures (SD 309)

Air Voids Specification

- 4.0% ± 1.0% V_a for all gyratory control levels
  - unless plan note to change the target
- Allow for VMA drop when selecting mix design air voids, design for anticipated drop in field air voids

Mix Design Calculations

- Complete all needed calculations
- Determine:
  - Air Voids, VMA, VFA, Effective AC Content, Marshall Stability and Flow, and Dust to Binder Ratio
- Gyratory Compactive Effort
- PLOT DATA
- Example Problem

Problem #3

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q3R Mix.

Use the equations found in SD 318.

Mix Temp	275
% binder Pb	6.0
Gsb	2.554
binder Gb	1.024
dust (- #200)	4.69
lime	1.00
dust(-#200) + lime	

	No. of gyrations		
N initial		Gse	
N design		Pba	
N max		Pbe	

	Spec. A (Ndes)		Spec. B (Ndes)				
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm	122.6	114.5	124.7	116.3	124.7	116.1	114.9
b) Weight in air		4697.7		4698.9			4696.8
c) Weight in water		2667.0		2668.2			2687.3
d) SSD Weight		4699.2		4700.4			4697.4
e) Gmb (measured) b / (d - c)							
f) Gmb (calculated)							

	Gmm #1	Gmm #2
Weight of sample in air	1545.1	1534.2
Weight of canister + H_2O	1365.4	1365.4
Weight of canister + H_2O + sample	2271.5	2264.1
Temperature of water	77.0	78.0
H_2O correction factor	1.0000	0.9999
Rice SpGr (Gmm)		

Average Max SpGr (Gmm)

	N initial	N design	N maximum
Average Gmb			
% of Rice SpGr (Gmm)			

% Air Voids (Va)		% VMA		% VFA		Dust to Binder Ratio	
Specs:							

Problem #3

DOT-86
Gyratory Worksheet

$$\textbf{dust}\ (-\#200)\ +\ \textbf{lime}\ =\ 4.69\ +\ 1.00\ =\ \mathbf{5.7}$$

$$\boldsymbol{Spec.A}:\ \textbf{Gmb measured}\ =\ \frac{\mathrm{b}}{(\mathrm{d}-\mathrm{c})}\ =\ \frac{4697.7}{(4699.2\ -\ 2667.0)}\ =\ \mathbf{2.312}$$

$$\boldsymbol{Spec.B}:\ \textbf{Gmb measured}\ =\ \frac{\mathrm{b}}{(\mathrm{d}-\mathrm{c})}\ =\ \frac{4698.9}{(4700.4\ -\ 2668.2)}\ =\ \mathbf{2.312}$$

$$\boldsymbol{Spec.A}:\ \textbf{Gmb calculated}\ =\ \frac{(\mathrm{Gmb(meas)}\ \times\ \mathrm{height\ @\ Ndes})}{(\ \mathrm{height\ @\ Nini}\ )}\ =\ \frac{(2.312\ \times\ 114.5)}{122.6}\ =\ \mathbf{2.159}$$

$$\boldsymbol{Spec.B}:\ \textbf{Gmb calculated}\ =\ \frac{(\mathrm{Gmb(meas)}\ \times\ \mathrm{height\ @\ Ndes})}{(\ \mathrm{height\ @\ Nini}\ )}\ =\ \frac{(2.312\ \times\ 116.3)}{124.7}\ =\ \mathbf{2.156}$$

$$\text{Average Gmb @ Ninitial}\ =\ \frac{(\ 2.159\ +\ 2.156\ )}{2}\ =\ 2.158$$

$$\text{Average Gmb @ Ndesign}\ =\ \frac{(\ 2.312\ +\ 2.312\ )}{2}\ =\ 2.312$$

No. of gyrations

- Spec. Book Sect. 322 (Q3R - Table G)
  - $N_{initial}$ = 6
  - N_{design} = 60
  - N_{max} = 85

Problem #3

DOT-86
Gyratory Worksheet

$$\textbf{@ N max: Gmb measured} = \frac{b}{(d-c)} = \frac{4696.8}{(4697.4 - 2687.3)} = \mathbf{2.337}$$

$$\textbf{N max (@ N ini): Gmb calculated} = \frac{(\text{Gmb(meas)} \times \text{height @ Nmax})}{(\text{height @ Nini})} = \frac{(2.337 \times 114.9)}{124.7} = \mathbf{2.153}$$

$$\textbf{N max (@ N des): Gmb calculated} = \frac{(\text{Gmb(meas)} \times \text{height @ Nmax})}{(\text{height @ Ndes})} = \frac{(2.337 \times 114.9)}{116.1} = \mathbf{2.313}$$

$$\textbf{Average Gmb @ Nmax} = \mathbf{2.337}$$

Problem #3

DOT-86
Gyratory Worksheet

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

$$\text{Gmm \#1} = \left[\frac{1545.1}{(1545.1 + 1365.4 - 2271.5)}\right] \times 1.0000 = \mathbf{2.418}$$

$$\text{Gmm \#2} = \left[\frac{1534.2}{(1534.2 + 1365.4 - 2264.1)}\right] \times 0.9999 = \mathbf{2.414}$$

$$\text{Average Max SpGr (Gmm)} = \frac{(2.418 + 2.414)}{2} = \mathbf{2.416}$$

$$\text{\% of Rice SpGr (Gmm) @ Ninitial} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.158}{2.416} \times 100 = \mathbf{89.3\ \%}$$

$$\text{\% of Rice SpGr (Gmm) @ Ndesign} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.312}{2.416} \times 100 = \mathbf{95.7\ \%}$$

$$\text{\% of Rice SpGr (Gmm) @ Nmax} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.337}{2.416} \times 100 = \mathbf{96.7\ \%}$$

Problem #3

DOT-86
Gyratory Worksheet

$$\%\ \textbf{Air Voids (Va)} = \left(\frac{\text{Gmm} - \text{Gmb}}{\text{Gmm}}\right) \times 100 = \left(\frac{2.416 - 2.312}{2.416}\right) \times 100 = \mathbf{4.3\%}$$

$$\textbf{Ps} = 100 - \text{Pb} = 100 - 6.0 = \mathbf{94.0\ \%}$$

$$\%\ \textbf{VMA} = 100 - \left(\frac{\text{Gmb} \times \text{Ps}}{\text{Gsb}}\right) = 100 - \left(\frac{2.312 \times 94.0}{2.554}\right) = \mathbf{14.9\ \%}$$

$$\%\ \textbf{VFA} = \left(\frac{\text{VMA} - \text{Va}}{\text{VMA}}\right) \times 100 = \left(\frac{14.9 - 4.3}{14.9}\right) \times 100 = \mathbf{71\ \%\ (whole\ percent)}$$

$$\textbf{Gse} = \frac{100 - \text{Pb}}{\left(\frac{100}{\text{Gmm}}\right) - \left(\frac{\text{Pb}}{\text{Gb}}\right)} = \frac{100 - 6.0}{\left(\frac{100}{2.416}\right) - \left(\frac{6.0}{1.024}\right)} = \mathbf{2.646}$$

Problem #3

DOT-86
Gyratory Worksheet

$$\textbf{Pba} = 100 \times \left(\frac{\text{Gse} - \text{Gsb}}{\text{Gse} \times \text{Gsb}}\right) \times \text{Gb} = 100 \times \left(\frac{2.646 - 2.554}{2.646 \times 2.554}\right) \times 1.024 = \mathbf{1.4\ \%}$$

$$\textbf{Pbe} = \text{Pb} - \left(\frac{\text{Pba} \times \text{Ps}}{100}\right) = 6.0 - \left(\frac{1.4 \times 94.0}{100}\right) = \mathbf{4.7\ \%}$$

$$\textbf{Dust to Binder Ratio} = \left(\frac{\text{dust} - \#200 + \text{lime}}{\text{Pbe}}\right) = \left(\frac{5.7}{4.7}\right) = \mathbf{1.2}$$

<u>Specs:</u> Spec Book - Sect. 322 (Q3R mix)

- TABLE L (% Air Voids) → **4.0% ± 1.0%**
- TABLE I (% VMA) → **minimum 14.5%**
- TABLE J (% VFA) → **65% – 78%**
- Dust to Binder Ratio → **0.6 to 1.4 -or- 0.8 to 1.6 (depends on gradation @ mix design)**

Problem #3

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q3R Mix.

Use the equation sheet in the Problems Packet.

Mix Temp	275
% binder Pb	6.0
Gsb	2.554
binder Gb	1.024
dust (- #200)	4.69
lime	1.00
dust(-#200) + lime	5.7

No. of gyrations			
N initial	6	Gse	2.646
N design	60	Pba	1.4
N max	85	Pbe	4.7

	Spec. A (Ndes)		Spec. B (Ndes)				
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm	122.6	114.5	124.7	116.3	124.7	116.1	114.9
b) Weight in air		4697.7		4698.9			4696.8
c) Weight in water		2667.0		2668.2			2687.3
d) SSD Weight		4699.2		4700.4			4697.4
e) Gmb (measured) b / (d - c)		2.312		2.312			2.337
f) Gmb (calculated)	2.159		2.156		2.153	2.313	

	Gmm #1	Gmm #2
Weight of sample in air	1545.1	1534.2
Weight of canister + H_2O	1365.4	1365.4
Weight of canister + H_2O + sample	2271.5	2264.1
Temperature of water	77.0	78.0
H_2O correction factor	1.0000	0.9999
Rice SpGr (Gmm)	2.418	2.414

Average Max SpGr (Gmm) 2.416

	N initial	N design	N maximum
Average Gmb	2.158	2.312	2.337
% of Rice SpGr (Gmm)	89.3	95.7	96.7
			≤ 98.0

% Air Voids (Va)	4.3	% VMA	14.9	% VFA	71	Dust to Binder Ratio	1.2
Specs:	4.0 ± 1.0		14.5 min		65 - 78		0.6 – 1.4 -or- 0.8 – 1.6

Mix Design Reports

- Submit all lab aggregate test data
- Submit all lab mix design test data
- Submit lab graphs
- Contractor Recommended Job Mix Formula and Asphalt Binder Content

Mix Design Verification Submittal to SDDOT

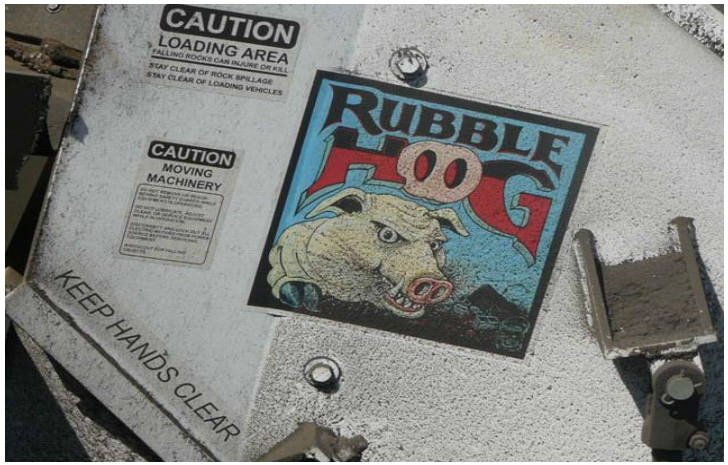
- Send materials to **PIERRE DOT MATERIALS LAB on Truck Route (104 S Garfield Ave Bldg. B)** at least 21 calendar days prior to hot mix production
- Provide aggregate stockpile tests per 1500 tons of material produced (certified testers)
- Label all materials (aggregate and binder)
- Include legal descriptions of all materials
- DOT Area Offices witness and send in samples or secure samples (green security tags) if Contractor brings to Pierre

Submitted Aggregate To SDDOT

- Must be representative of stockpiles produced or will need to resubmit samples
- Sample size is large enough to do all required mix and quality tests
- Submitted by Contractor or representative when secured by SDDOT field tags to Bituminous mix design section in Pierre

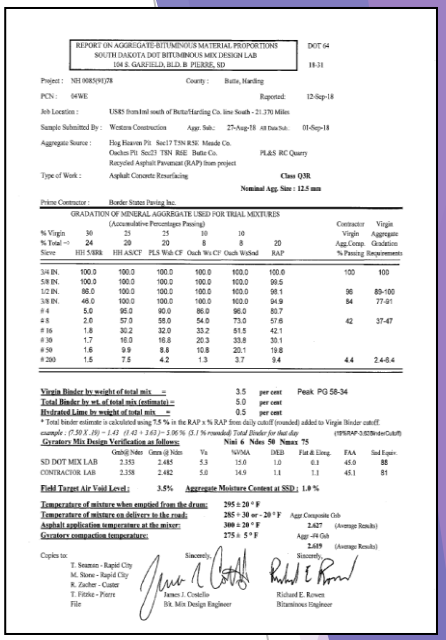
RAP Testing

- 1 per day for gradation
  - (100% passing 1 ½” and 95-100 passing 1”)
- 1 per day for moisture content
- RAP content (end of day)



SDDOT Verification

- Aggregate and binder submitted
- DOT conducts aggregate quality tests
- DOT does mix design verification
- DOT does moisture sensitivity verification
- Send out Mix Design Report (DOT-64)
  - e-mail to Contractor and DOT Area Office



REPORT ON AGGREGATE-BITUMINOUS MATERIAL PROPORTIONS
SOUTH DAKOTA DOT BITUMINOUS MIX DESIGN LAB
104 E. GAUFFIELD, BLD. B PIERRE, SD

DOT 64
10-31

Project : NH 0085(91)78 County : Butte, Harding

PCN : 04WE Reported: 12-Sep-18

Job Location : US85 from Intl south of Butte/Harding Co. line South - 21.370 Miles

Sample Submitted By : Western Construction Aggr. Sub.: 27-Aug-18 AB Date/Sub.: 01-Sep-18

Aggregate Source : Hog Heaven Pit Sec17 T5N R5E Meade Co.
Ouches Pit Sec23 T5N R6E Butte Co. PL&S RC Quarry
Recycled Asphalt Pavement (RAP) from project

Type of Work : Asphalt Concrete Resurfacing **Class Q3R**
Nominal Agg. Size : 12.5 mm

Prime Contractor : Border States Paving Inc.

GRADATION OF MINERAL AGGREGATE USED FOR TRIAL MIXTURES
(Accumulative Percentages Passing)

% Virgin	30	25	25	10	10			Contractor Virgin Agg.Comp. % Passing	Virgin Aggregate Gradation Requirements
% Total ->	24	29	20	8	8	20			
Sieve	HH 5/8Rk	HH AS/CF	PLS Wsh CF	Ouch Wsh CF	Ouch WsSnd	RAP			
3/4 IN.	100.0	100.0	100.0	100.0	100.0	100.0		100	100
5/8 IN.	100.0	100.0	100.0	100.0	100.0	99.5			
1/2 IN.	86.0	100.0	100.0	100.0	100.0	98.1		96	89-100
3/8 IN.	46.0	100.0	100.0	100.0	100.0	94.9		84	77-91
# 4	5.0	95.0	90.0	86.0	96.0	80.7			
# 8	2.0	57.0	58.0	54.0	73.0	57.6		42	37-47
# 16	1.8	30.2	32.0	33.2	51.5	42.1			
# 30	1.7	16.0	16.8	20.3	33.8	30.1			
# 50	1.6	9.9	8.8	10.8	20.1	19.6			
# 200	1.5	7.5	4.2	1.3	3.7	9.4		4.4	2.4-6.4

Virgin Binder by weight of total mix = 3.5 **per cent** Peak PG 58-34
Total Binder by wt. of total mix (estimate) = 5.0 **per cent**
Hydrated Lime by weight of total mix = 0.5 **per cent**
* Total binder estimate is calculated using 5.5 % in the RAP x % RAP from daily cutoff (rounded) added to Virgin Binder cutoff.
example : (7.50 X .10) = 1.43 (1.42 + 2.63) = 3.06 % (3.1 % rounded) Total Binder for that day (10%RAP-3.52Binder Cutoff)

Gyratory Mix Design Verification as follows: **Ninit 6 Ndes 50 Nmax 75**

	Gmb@Ndes	Gmm @ Ndes	Va	%VMA	%VEB	Flat & Elong.	FAA	Sod Equiv.
SD DOT MIX LAB	2.353	2.485	5.3	15.0	1.0	0.3	45.0	88
CONTRACTOR LAB	2.358	2.482	5.0	14.9	1.1	1.3	45.1	81

Field Target Air Void Level : 3.5% Aggregate Moisture Content at SSD : 1.0 %

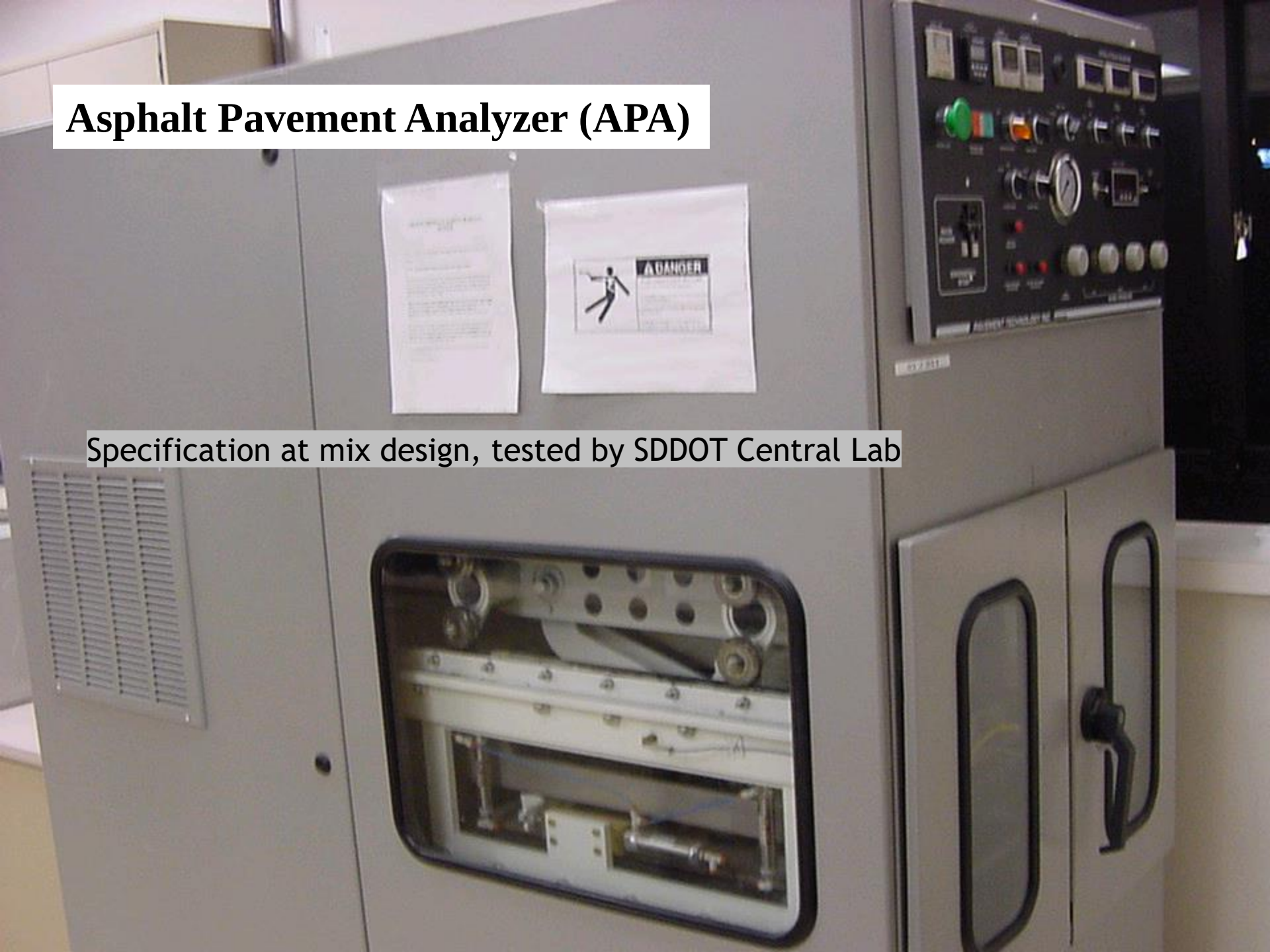
Temperature of mixture when emptied from the drum: **295 ± 20 ° F**
Temperature of mixture on delivery to the road: **285 + 30 or - 20 ° F** Agg Composite Gsb
Asphalt application temperature at the mixer: **300 ± 20 ° F** **2.627** (Average Results)
Gyratory compaction temperature: **275 ± 5 ° F** Agg -#4 Gsb
2.619 (Average Results)

Copies to:
T. Seamon - Rapid City
M. Stone - Rapid City
R. Zacher - Custer
T. Fitzke - Pierre
File

Sincerely,
James J. Costello
Bit. Mix Design Engineer

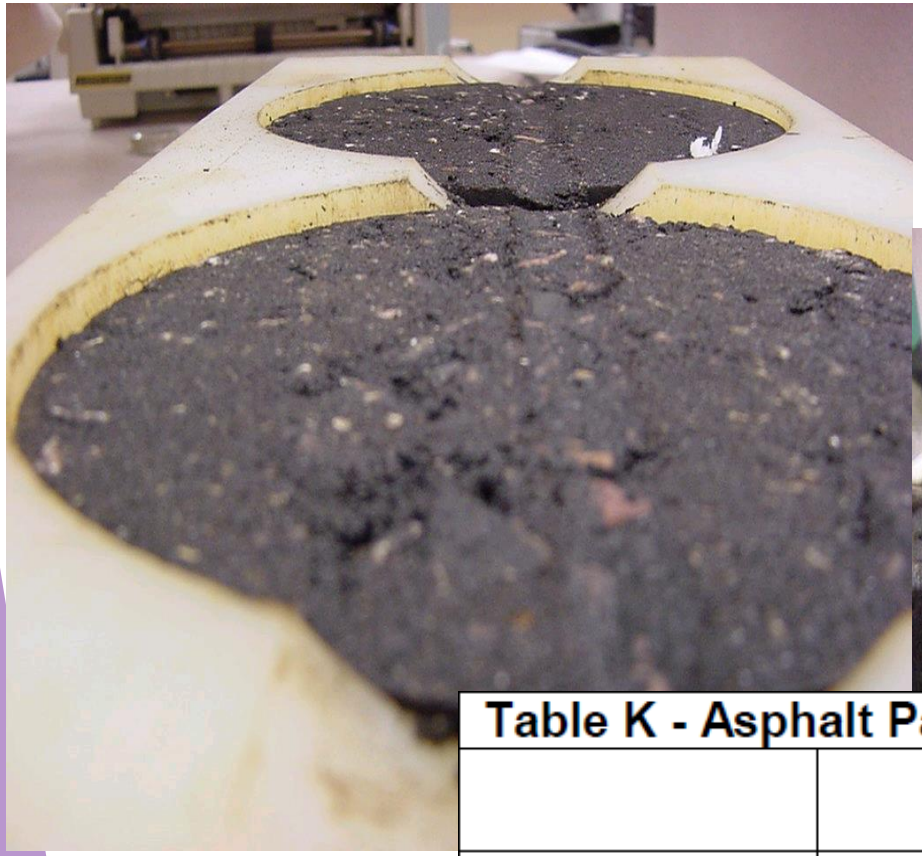
Sincerely,
Richard E. Rowen
Bituminous Engineer

Asphalt Pavement Analyzer (APA)



Specification at mix design, tested by SDDOT Central Lab

Asphalt Pavement Analyzer (APA) - Specs



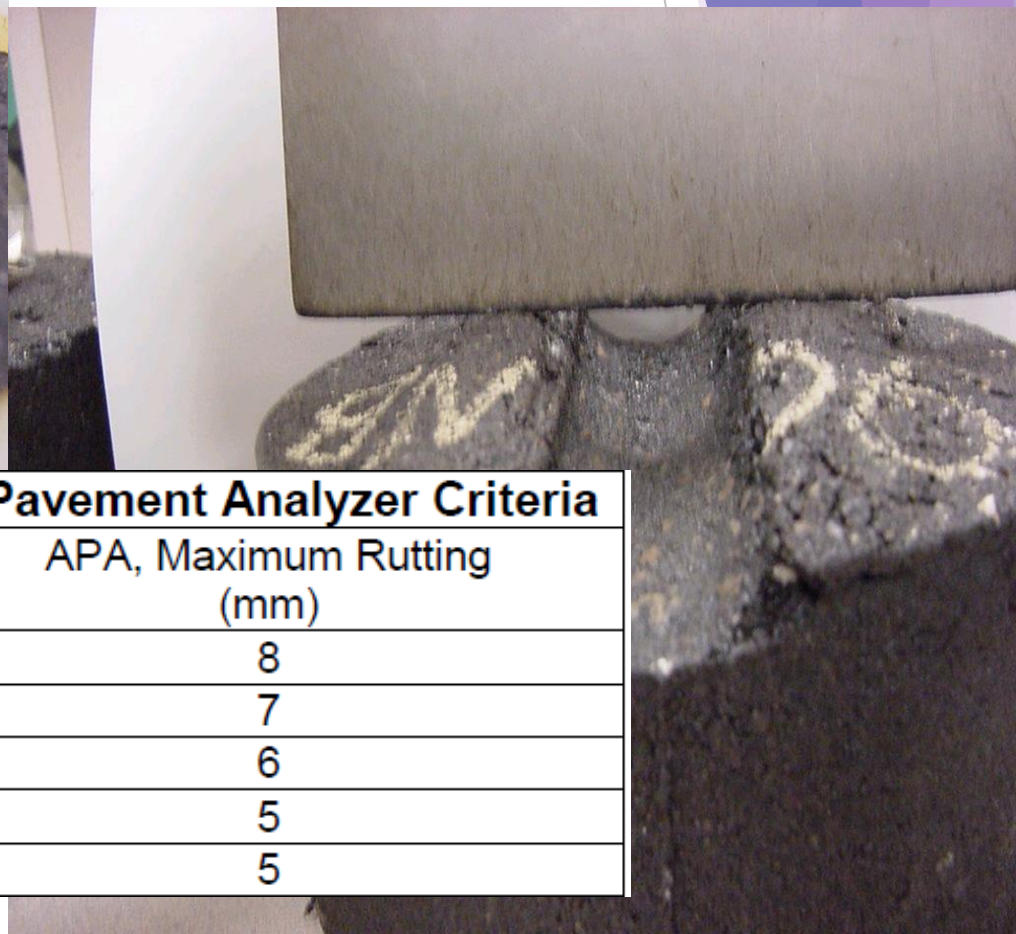


Table K - Asphalt Pavement Analyzer Criteria	
	APA, Maximum Rutting (mm)
Class Q1	8
Class Q2	7
Class Q3	6
Class Q4	5
Class Q5	5

Field Correlation Testing Gyratory Control

- Between QC and QA technicians
- Sample supplied by Contractor
  - May be plant produced, if spot leveling
- Gyratory (SD 318)
- Theoretical Max. Sp. Gr. [Rice] (SD 312)
- Air Void calculation on form DOT-69

Field Samples

- Location
  - sample obtained from windrow at paver at a random location (SD 312)
- Sample size
  - enough for 4 splits, large enough for all tests required
- Split down to testing size, quartering method
- Frequency of needed tests
  - QC 1 per 1,000 tons, minimum QA 1 per 5,000 tons, IA one per 15,000 tons
- Retention of split portions of samples
  - QA until F and t tests completed by Bituminous Engineer

Field Bulk Specific Gravity Reheat Correlation

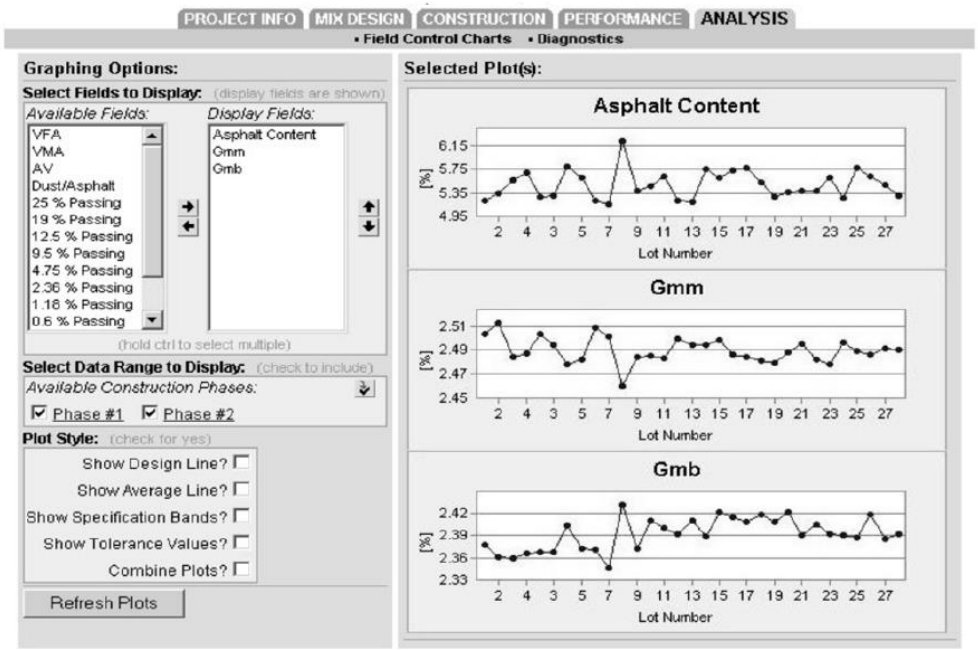
- 1st sublot of material
- Cool to room temperature, reheat to compaction temperature
- Used for IA tolerances and if QC vs. QA correlation problems occur
- Shows aggregate and asphalt mixture absorption rates

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

Field Production Control Charts

- QC maintains charts for all required properties shown in Specifications
- Contractor (QC) is responsible for maintaining all process control charts and adding QA and IA tests to charts



Field (mix) Problems
Air Void Problems

- Low Voids
  - Drop in VMA
  - Increase in amount passing -#200 sieve
- High Voids
  - Low binder content
  - Change aggregate gradation
  - No lime

In-Place Density Problems

- High gyratory air voids
- Low VMA
- Not measuring field in-place density
- Temperature of mix at time of compaction rolling is too low or not uniform
- Mix instability
- Base problems
- Compaction equipment problems or not enough rollers

Common Gradation Problems

- Incorrect or inconsistent stockpile gradations
- Job Mix Formula tolerances
  - Table N – Sect. 322
- Variable or segregated stockpiles
- Insufficient stockpile samples at design
- Bin splits incorrect
- Improper loading of cold bins
- Inconsistent feeds from the cold bins
  - wet material sticking in or bridging bins

Segregation

F and t tests (Example)

Quality Control Tests			
Test No.	Gmm	Gmb	Va
avg	2.457	2.369	3.53
stdev	0.0123	0.0106	0.698
F-test	0.2064	0.1477	0.482
	between QC AND QA		
0.01	OK	OK	OK
0.025	OK	OK	OK
t-test	0.1475	0.3154	0.175
0.01	OK	OK	OK
t-test	0.1475	0.3154	0.175
0.025	OK	OK	OK

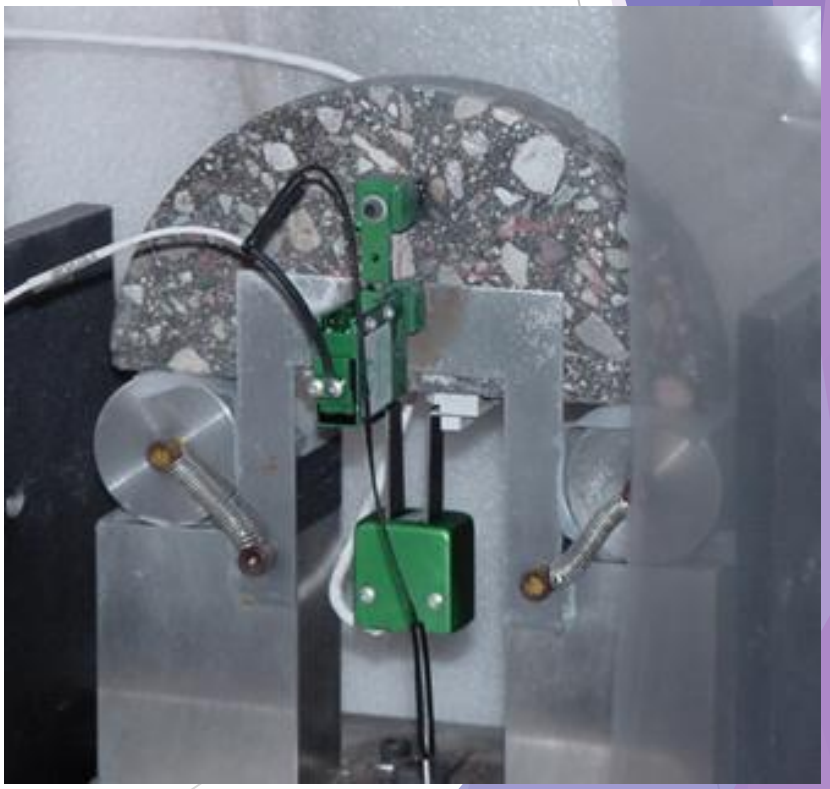
Quality Assurance Tests			
Test No.	Gmm	Gmb	Va
avg	2.449	2.375	3.05
stdev	0.0069	0.0166	0.853
F-test	0.25287	0.3213	0.978
	between QA AND IA		
	OK	OK	OK
	OK	OK	OK
t-test	0.24304	0.79704	0.484
	OK	OK	OK
t-test	0.24304	0.79704	0.484
	OK	OK	OK

Independent Assurance Tests			
Test No.	Gmm	Gmb	Va
avg	2.458	2.372	3.55
stdev	0.0127	0.00354	0.636
F-test	0.63106	0.51315	0.75
	between IA AND QC		
	OK	OK	OK
	OK	OK	OK
t-test	0.93991	0.75417	0.97
	OK	OK	OK
t-test	0.93991	0.75417	0.97
	OK	OK	OK

*Must be completed before QA discards back-up samples

Low Temperature Cracking Resistance

- Disc-Shaped Compact Tension (DCT) test
- Semi-Circular Bend (SCB) Test



Recertification 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.