

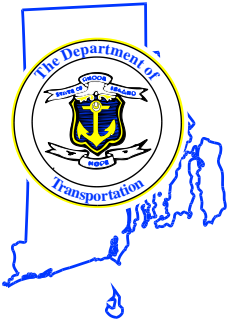
# *Rubberized Asphalt in Pavement Preservation & Construction*

*NEWMOA Workshop*

*April 9, 2019*

*Hartford, CT*

*Colin A. Franco, P.E.  
RIDOT*

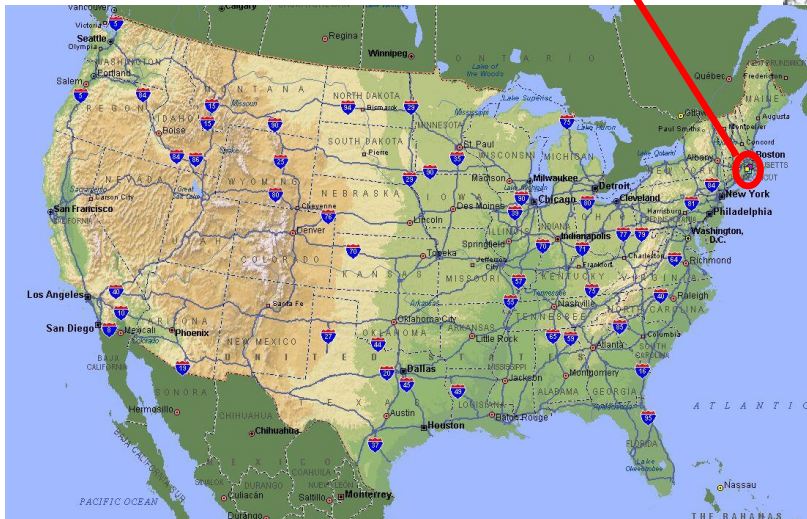
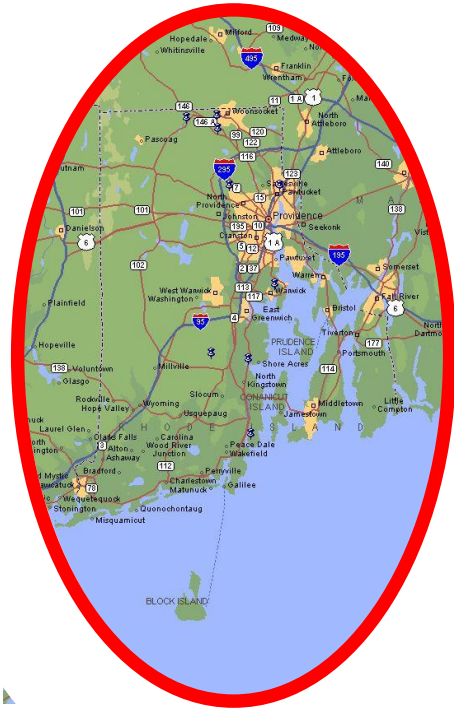


# *Presentation Outline*



- 1) Introduction
- 2) RIDOT Experience with Crumb Rubber Asphalt
- 3) Pavement Preservation/Construction Experience
- 4) Crack Sealing – w/Crumb Rubber Asphalt
- 5) Chip Sealing – w/Crumb Rubber Asphalt
- 6) Thin Overlay - w/Crumb Rubber Asphalt

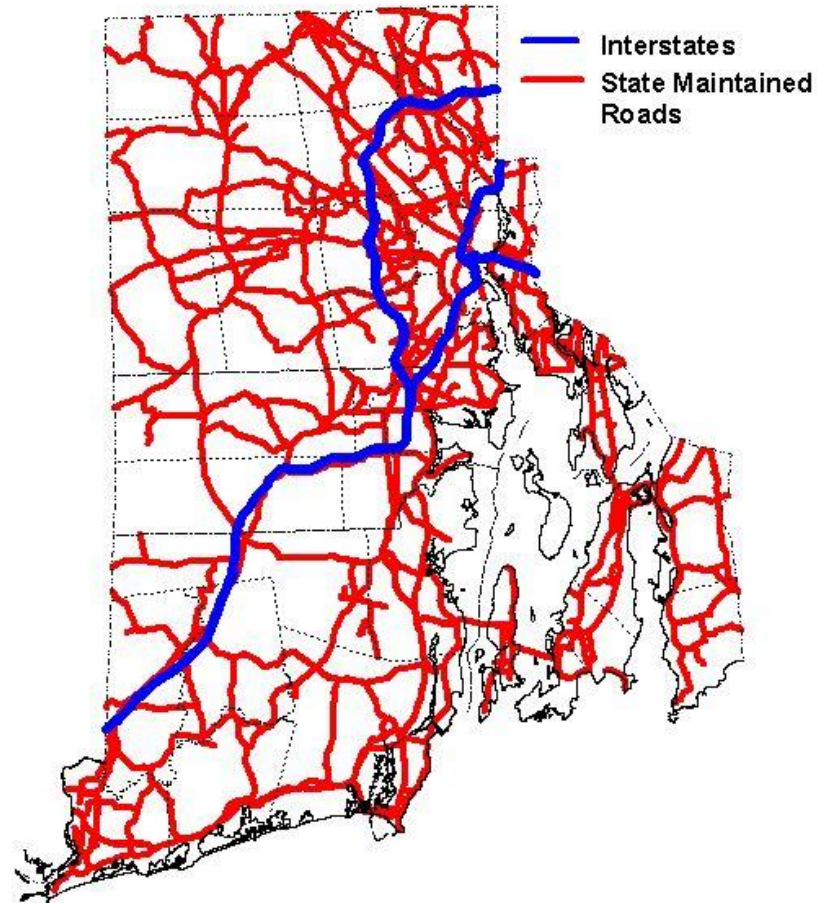
# *Rhode Island*



# *RIDOT Highway Data (2018) - RI*

	<b>RI</b>
Area (Thousand sq. mi.)	1
Population (Million)	1
Daily VMT (Million)	23
All Road Miles (Thousand)	6.4
SHA	1.1
Other	5.3
<b>SHA ROADS</b>	
Miles (Thousand)	1.1
Lane Miles (Thousand)	3
Daily VMT (Million)	19
<b>BRIDGES</b>	
Total Bridges	773
Deficient Bridges (%)	24
SHA Bridges	603
SHA Bridges (%)	60
<b>STATE FUNDING (\$Million)</b>	
Total (RIDOT)	677
Capital Outlay (Pavement)	68
Maintenance (Pavt. Preserv.)	7.2

# *RIDOT Maintained Roads*



# *Background - RIDOT's Experience with Crumb Rubber*



- 1987 – Demo Project with Plusride
- 1991 – ISTEA National Mandate – Research with crumb rubber asphalt
- 1999 to 2019 – Crumb rubber asphalt used in Pavement Preservation/Construction Program
  - Crack Seal
  - Chip Seal
  - Modified Asphalt Thin Overlay
  - Rehabilitation
- 2005 – Use of crumb rubber with warm asphalt technology in Rubber Chip Seal

# *Plusride Project*

## *— Crumb Rubber Aggregate*



- Year Placed – 1987
- Location – Rt. 2 in East Greenwich
- Mix Details
  - AC - 8.2%
  - Rubber – 3.5%, max nominal size 1/4"
  - Aggregate – 88.3%
- Layer Thickness – 1.5"
- Performance – Ravelling of Rubber and Aggregate within 5 years.

**Conclusion: Not Effective Treatment**

# *1991 - ISTEA Mandate - Research*



- Research at URI on crumb rubber asphalt binder using Arizona Wet Process SuperPave Binder Specification
- PG binder range of virgin asphalt extended 2 to 3 grades
- Mixture testing indicated rutting would be mitigated



# *1999-2005 Pavement Preservation*



- Worked with Hudson/All States Asphalt to incorporate the **chemically modified crumb rubber asphalt** (CMCRA) into the following
- Crack seal – Low viscosity CMCRA w/fibers
- Chip Seal – Used CMCRA in demo sections with chip seal (requires less rubber)
- Elastomeric Mix – Used CMCRA binder to produce crack resistant mix
- Also used in department's construction overlay program

# *New Generation of Chemically Modified Crumb Rubber Asphalt (CMCRA)*



Enhanced chemical bond between asphalt and crumb rubber molecules due to addition of chemical bonding agent

- Improves both ends of the binder PG grade (most importantly at the low end)
- Improves elastic properties (Elastic Recovery Test)
- Improves separation characteristics

Terminal blending is required to provide a consistent quality mix

# *Paver-Placed Elastomeric Surface Treatment — New Technology*

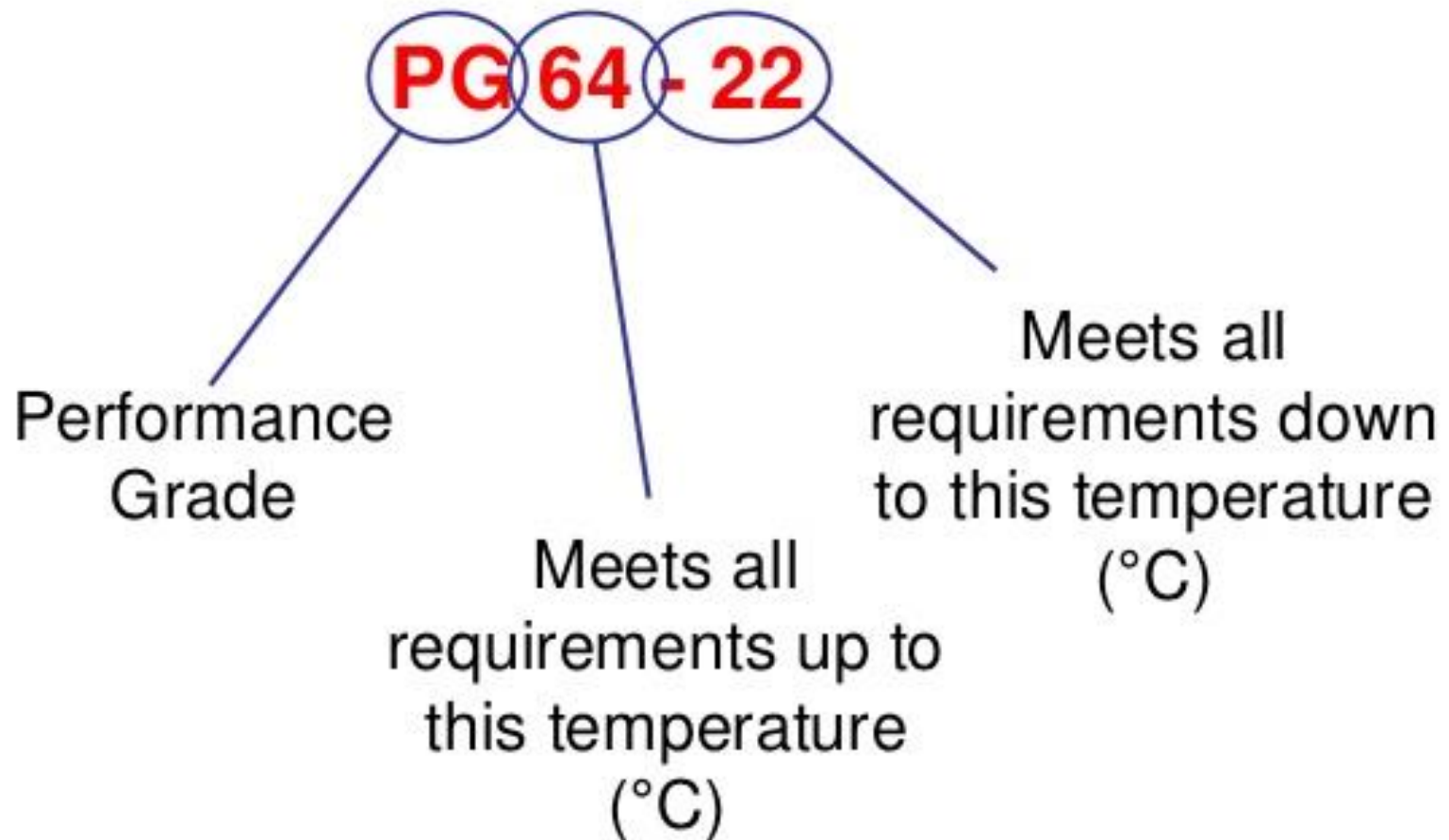









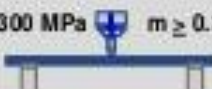

*PG ASPHALT & CMCRA*

# PG Binder Specifications

The PG grading system is based on Climate



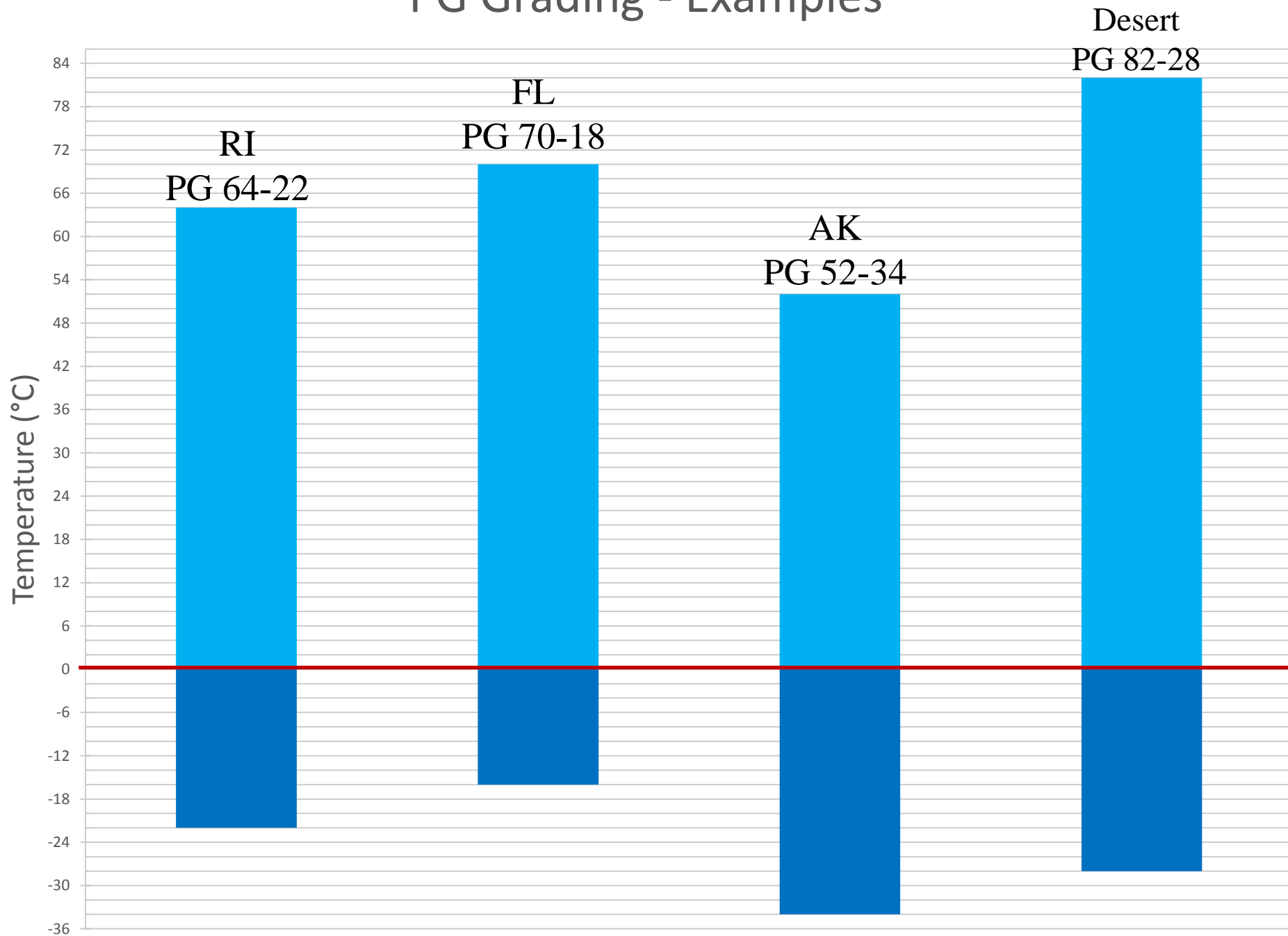
# Performance Grades M320 Table

Avg 7-day Max, °C	PG 46			PG 52			PG 58			PG 64			PG 70			PG 76			PG 82													
1-day Min, °C	-34	-40	-46	-10	-16	-22	-28	-34	-40	-46	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34
ORIGINAL																																
 ≥ 230 °C	(Flash Point) FP																															
 ≤ 3 Pa·s @ 135°C	(Rotational Viscosity) RV																															
 ≥ 1.00 kPa	(Dynamic Shear Rheometer) DSR G*/sin δ																															
	46	52				58				64				70				76				82										
(ROLLING THIN FILM OVEN) RTFO Mass Loss ≤ 1.00 %																																
 ≥ 2.20 kPa	(Dynamic Shear Rheometer) DSR G*/sin δ																															
	46	52				58				64				70				76				82										
(PRESSURE AGING VESSEL) PAV																																
20 Hours, 2.07 MPa	90	90				100				100				100 (110)				100 (110)				100 (110)				100 (110)						
 ≤ 5000 kPa	(Dynamic Shear Rheometer) DSR G* sin δ																															
	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16	34	31	28	25	22	19	37	34	31	28	25
S ≤ 300 MPa  m ≥ 0.300	(Bending Beam Rheometer) BBR "S" Stiffness & "m"-value																															
	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24
Report Value	(Bending Beam Rheometer) BBR Physical Hardening																															
 ≥ 1.00 %	(Direct Tension) DT																															
	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24

		Performance Grade					
		PG 64					
		10	16	22	28	34	40
Climatic Conditions	Average 7-day maximum pavement design temperature °C	< 64					
	Minimum pavement design temperature, °C	> -10	> -16	> -22	> -28	> -34	> -40
		Original binder					
		Flash point temp, T48, minimum °C					
		230					
		Viscosity, T 316: maximum 3 P a.s, test temp, °C					
		135					
Rutting	Dynamic shear, T315: $(G' / \sin \delta)$ , minimum 1.0 kPa, test temp @ 10 rad/s, °C	64					
		Rolling Thin film Oven Residue (T240)					
	Mass change, maximum, %	1.0					
	Dynamic shear, T315: $(G' / \sin \delta)$ , minimum 2.2 kPa, test temp @ 10 rad/s, °C	64					
		Pressure Aging Vessel Residue (R28)					
		PAV ageing temperature					
		100					
Fatigue	Dynamic shear, T315: $(G' \cdot \sin \delta)$ , maximum 5000 kPa, test temp @ 10 rad/s, °C	31	28	25	22	19	16
Brittle Fracture	Creep stiffness, T313: S, maximum 300 MPa, m-value, minimum 0.3, test temp @ 60s, °C	0	-6	-12	-18	-24	-30
	Direct tension, T314. Failure strain, minimum 1.0%, test temp @ 1.0mm/min, °C	0	-6	-12	-18	-24	-30



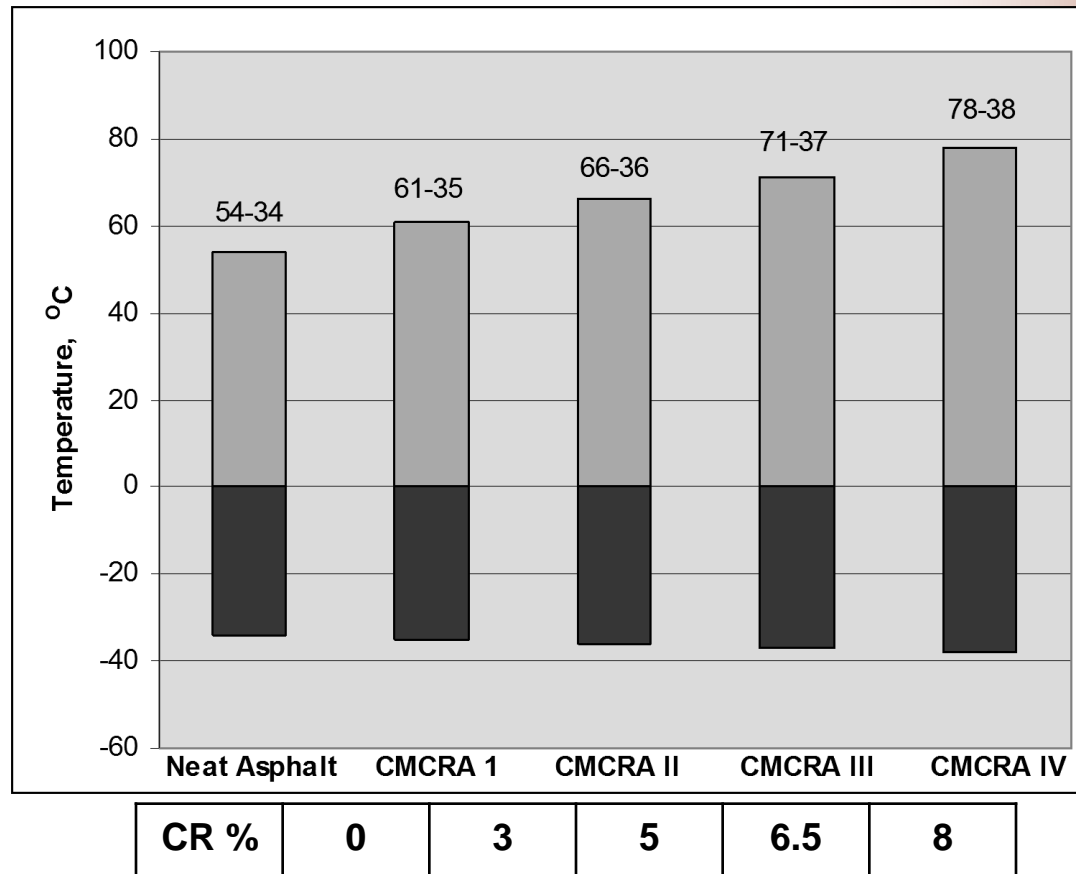
# PG Grading - Examples





# *Crumb Rubber Asphalt*

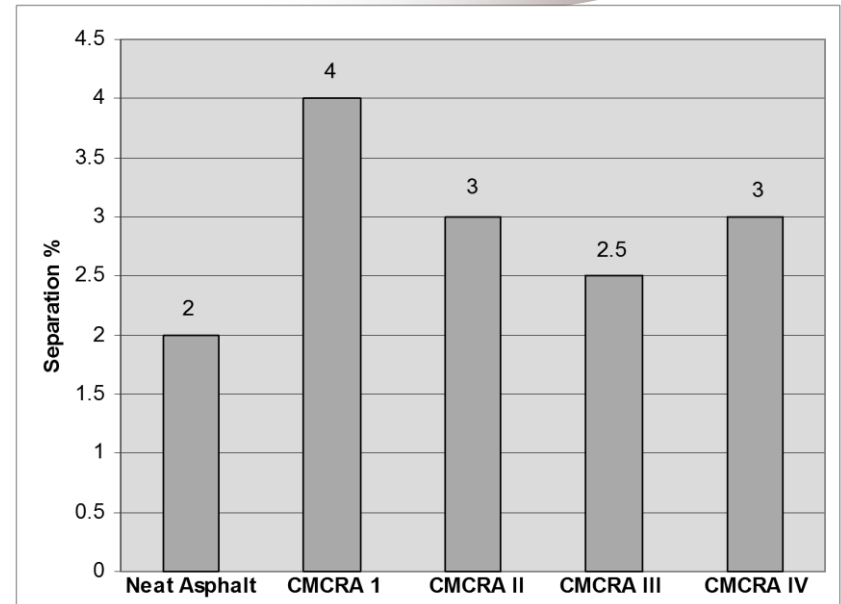
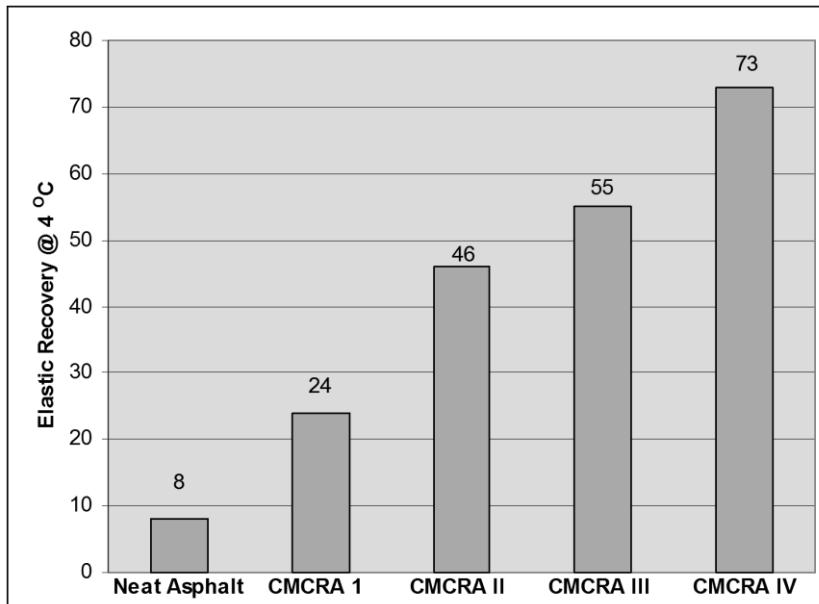
## *– PG Grades*



**Continuous or True PG grades for  
neat asphalt & its CMCRA**

# *Crumb Rubber Asphalt*

## *— Elastic Recovery and Separation*



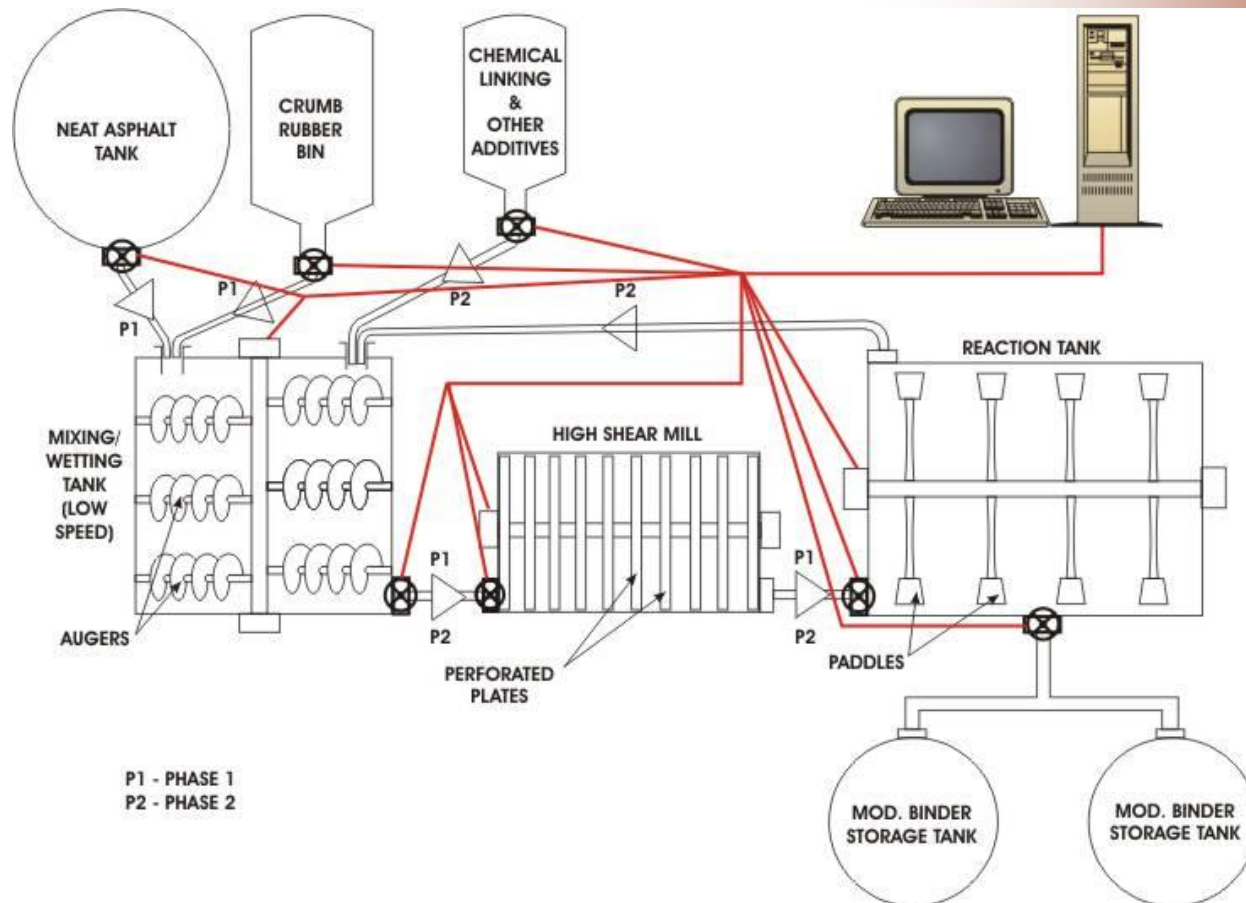
CR %	0	3	5	6.5	8
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**Elastic recovery of neat asphalt &  
its CMCRA @ 4°C+**

CR %	0	3	5	6.5	8
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**Separation results for neat asphalt &  
its CMCRA**

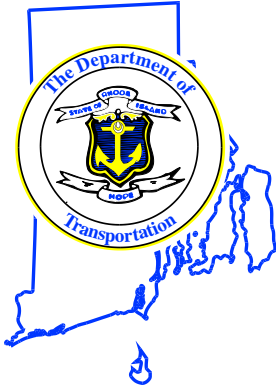
# *Crumb Rubber Asphalt Manufacturer Terminal Blending*



**CRUMB RUBBER ASPHALT BLENDING SCHEMATIC** (Not to Scale)

# *Crumb Rubber Asphalt Terminal Blending with Automation*





***RIDOT***

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Pavement Preservation Program (P<sup>3</sup>) using  
Asphalt Rubber  
1998 - Present

# *Pavement Preservation Treatments*



- Rhode Island experience to date
  - ✓ Crack Seal/Rout and Seal w/Crumb Rubber Asphalt
    - Microsurfacing
  - ✓ Rubberized Chip Seal w/Crumb Rubber Asphalt
    - Paver-Placed Surface Treatment
  - ✓ Elastomeric Mix w/Crumb Rubber Asphalt
  - ✓ Combination Cape Seal/SAMI w/Crumb Rubber Asphalt
    - Whitetopping (Concrete Intersections)

✓ = Contains Asphalt Rubber

# *Crack Sealing*

## *— Definition*



- Crack Seal – Blow clean and heat crack; fill and overband with fiber and chemically modified crumb rubber asphalt
- Rout and Seal – Grind out and heat crack; fill with fiber and chemically modified crumb rubber asphalt

# *Crack Seal Material Composition*



- A) Hot Applied – ASTM 6690 Type II Pre-packaged Block Sealer
- B) Chemically Modified Crumb Rubber Asphalt\*
  - Neat Asphalt – PG 58 – XX
  - Crumb Rubber – Minimum 5%, 80 mesh
  - Chemical Bonding Agent
  - Blend AC – PG 70-34/64-34, Visc. – 3 Pa · s @ 300°F
  - Fibers – 10 mm length polyester, 15 dpf

\*Terminal Blend



# *Crack Sealing — Heating Kettle*



# *Crack Sealing*

## *— Preparation (Hot Air Lance)*

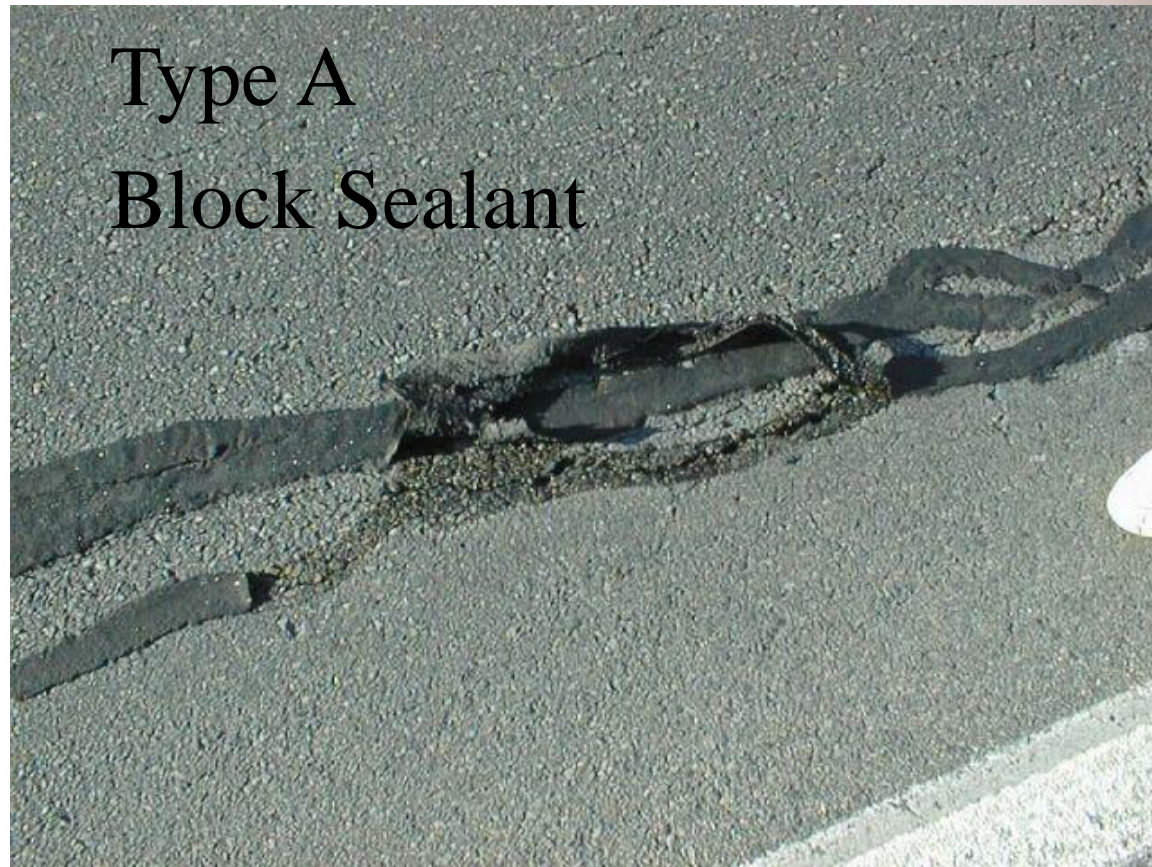




# *Crack Sealing* — *Sealing Operation*



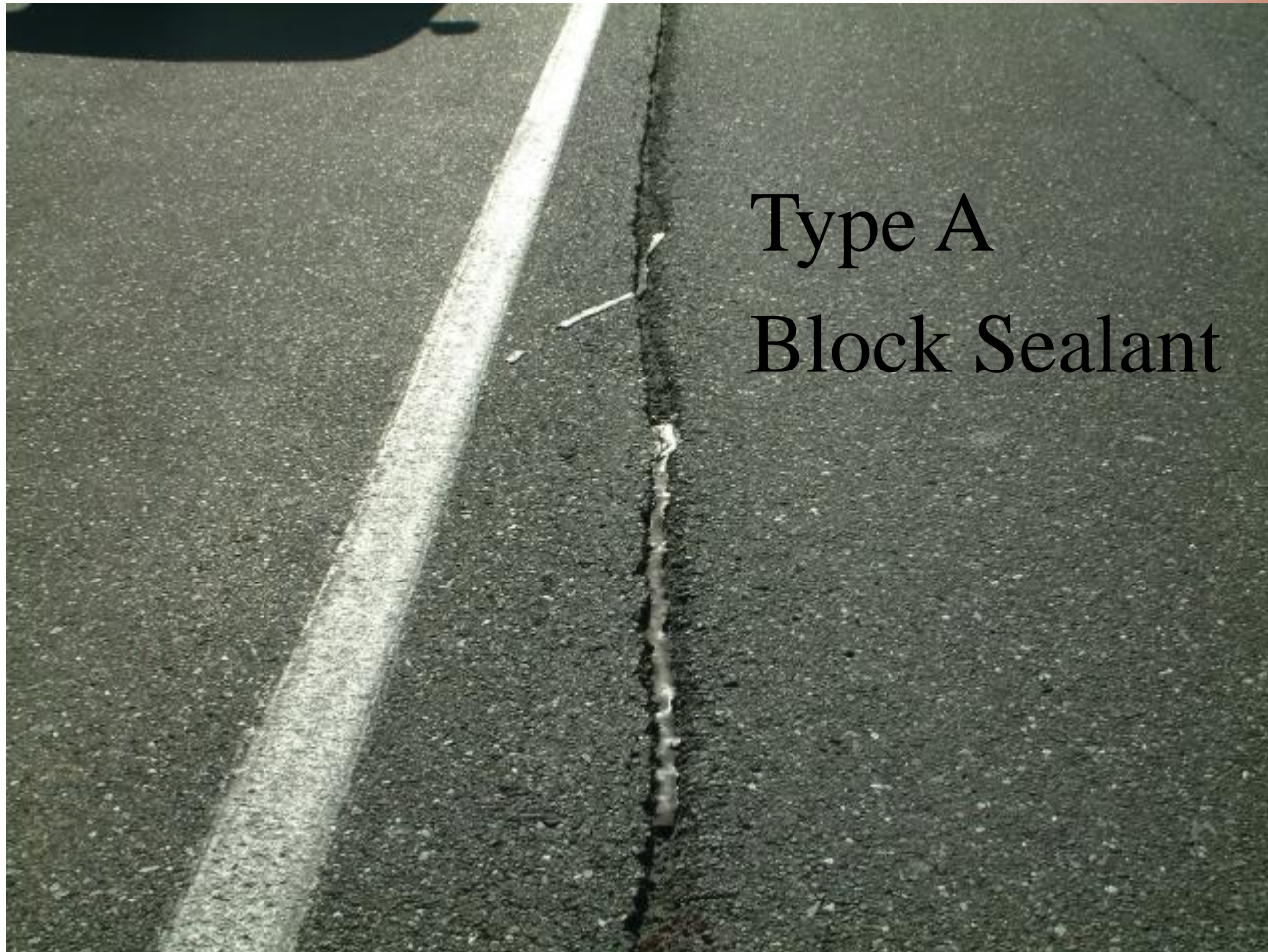
# *Crack Sealing Block Sealer — Failure*





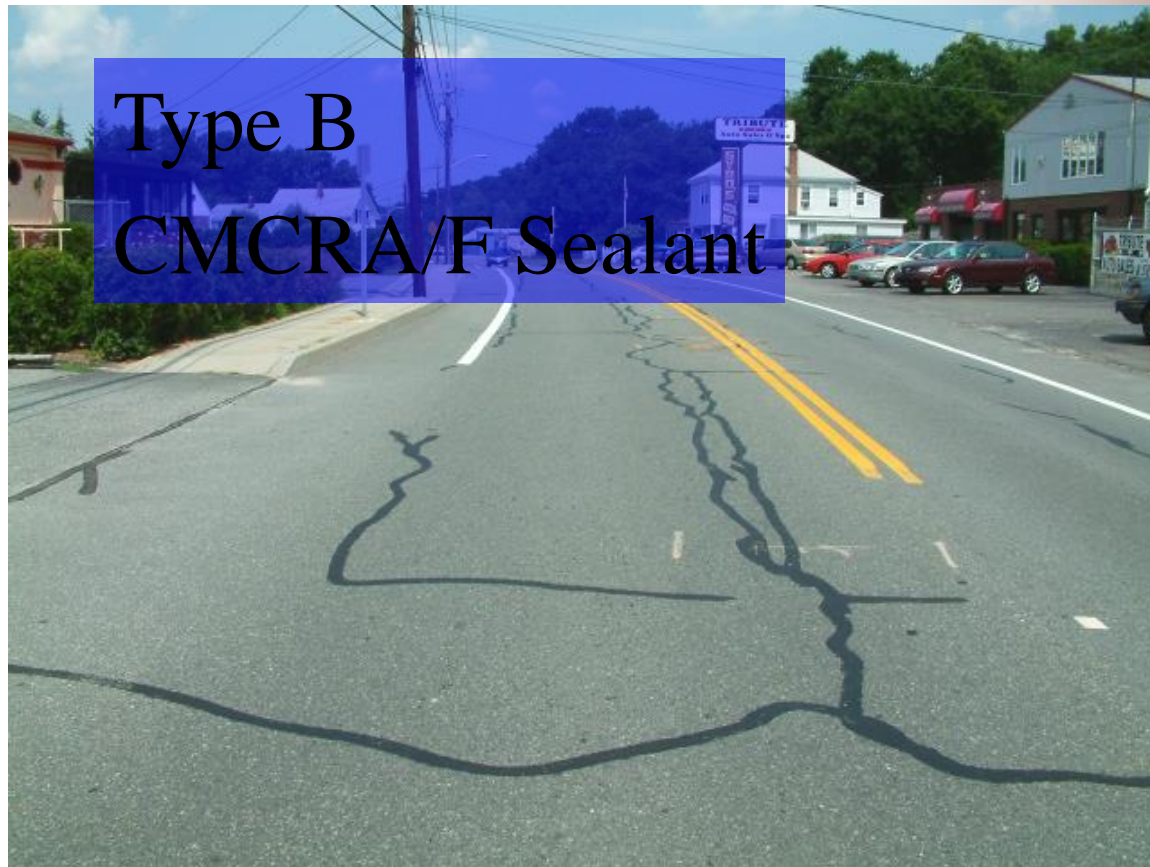
# *Crack Sealing*

## *Block Sealer — Failure @ 3-4 Years*



Type A  
Block Sealant

# *Crack Sealing* *CMCRA — Performance @ 3 Years*




# *Crack Sealing*



- RIDOT Crack Seal Usage (2014 – 2018):
  - 16,333,500 Linear Ft
  - 757 tons

# *Rubberized Asphalt Chip Seal (RACS) — Description*



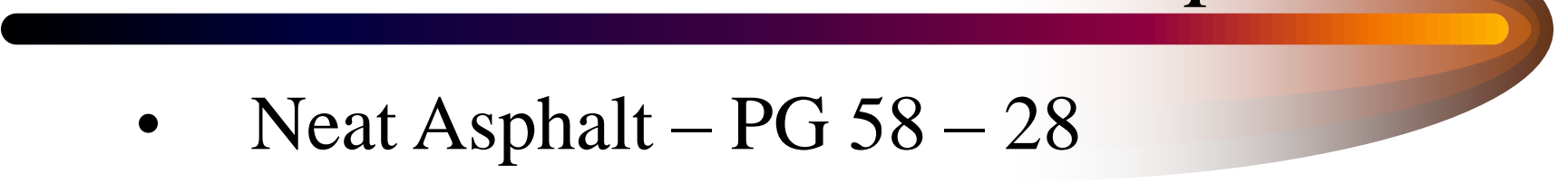
The RACS binder is a blend\* of 20% crumb rubber (#20 mesh) and asphalt. RACS is hot spray-applied at the rate of 0.6 gallons per square yard. Then covered with Single Size 3/8" or 1/2" precoated stone, followed by rolling.

- Flexible - Good for moderately cracked roads.
- Relatively easy/fast to apply
- Ideal for cold wet climates
- Other unique applications

\*Terminal Blend



# *Rubberized Asphalt Chip Seal Material Composition*



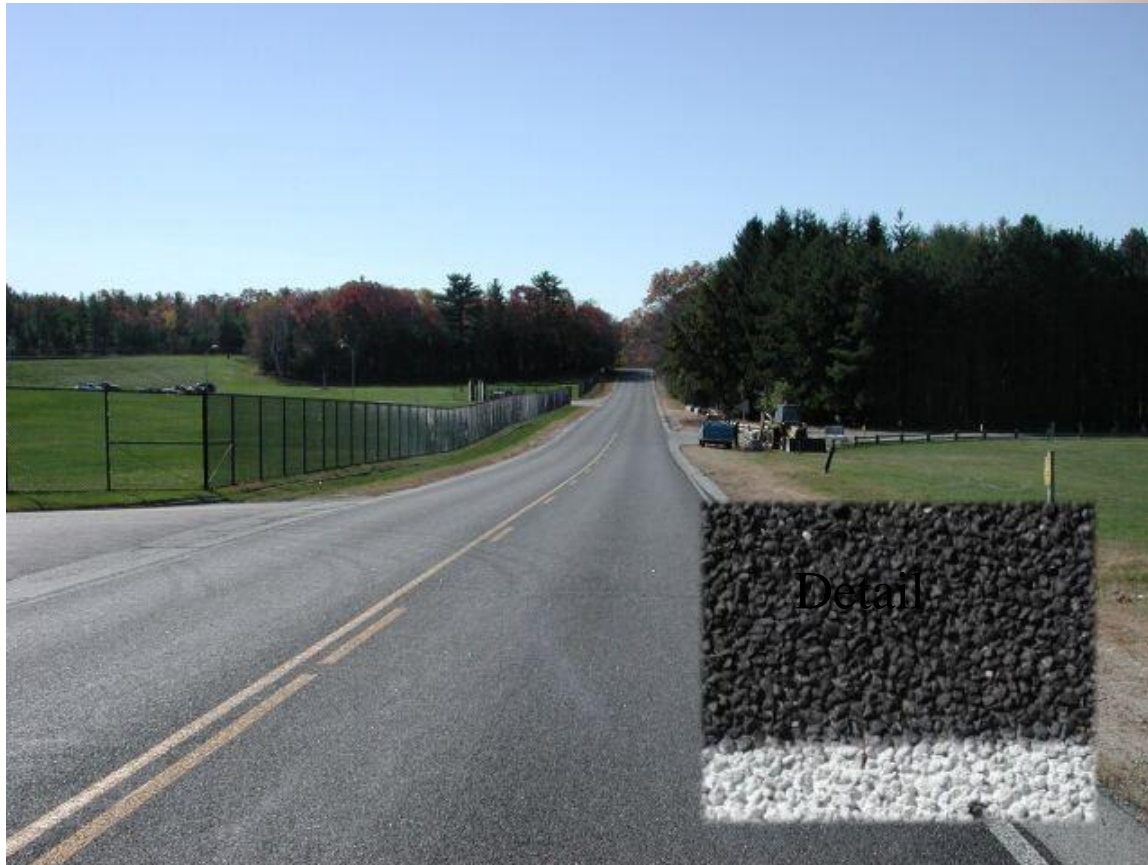
- Neat Asphalt – PG 58 – 28
- Rubber – Size #20 sieve
- Rubber % -  $20 \pm 3$
- Aggregate Size –  $\frac{1}{4}$ " to  $\frac{1}{2}$ " (single size)
- Aggregate Coating – 100% coating  
w/PG 58 - 22

# *Rubberized Asphalt Chip Seal Prep*

## *- Shim and Crack Seal*



# *Rubberized Asphalt Chip Seal* *— Completed Treatment*



# *Rubberized Asphalt Chip Seal* — *Sprayer*





# *Rubberized Asphalt Chip Seal — Chip Spreader*



# *Rubberized Asphalt Chip Seal* *— Rolling*



# *Rubberized Asphalt Chip Seal Suspension Bridge Deck — Unique Applications*





# *Rubberized Asphalt Chip Seal Failed Pavement Fix — Unique Applications*

Pound Hill Rd.





# *Rubberized Asphalt Chip Seal* — *Unique Applications*





# *20 Years Later*

Pound Hill Rd.





# *Rubberized Asphalt Chip Seal* — *Unique Applications*



Concrete Pavement

# *Rubberized Asphalt Chip Seal Issues — Bleeding @ Intersection*





# *Rubberized Asphalt Chip Seal Issues — Improper Roller*



# *Rubberized Asphalt Chip Seal Issues — Adhesion Failure*





# *Rubberized Asphalt Chip Seal Issues — Streaking*



# *Rubberized Asphalt Chip Seal Issues — Stone Kick Out*





# *RCS*

- RIDOT RCS usage over 5 years:
  - 1,500,000 square yards @ 0.6 gal containing 20% rubber
  - 1,500,000 lbs = 750 tons

# *Paver-Placed Elastomeric Surface Treatment (PPEST) — Definition*



PPEST is a gap graded mix of 3/8 inch crushed aggregate and a chemically modified crumb rubber asphalt (CMCRA) binder\*. The binder is PG 76-34 and contains a minimum 7% CMCR. The mix has a binder content of 6.0 to 7.5%. PPEST is:

- Produced in a Conventional hot mix plant
- Applied to a tack-coated surface
- Placed to a one-inch compacted thickness

\*Terminal Blend

# Elastomeric Surface Treatment - PPEST



## Material/Properties of PPEST

- Neat Asphalt – PG 58 – XX
- Crumb Rubber – 7%
- Chemical Bonding Agent
- Asphalt Blend – PG 76 – 34

Separation < 5%,      PAV < 5000 KPa @ 7 °C,

Elastic Recovery  $\geq$  70% @ 4°C

- Aggregate – Maximum size 1/2"
- Marshall Mix Design – Stability 1000 lbs, Flow 8-16



# *Paver-Placed Elastomeric Surface Treatment — Before*



# *Paver-Placed Elastomeric Surface Treatment — After*





# *Paver-Placed Elastomeric Surface Treatment — Train*



# *Paver-Placed Elastomeric Surface Treatment — Roller*





# *PPEST*

## *Issues — Tack Streaking*





# *PPEST*

## *Issues — Tearing*



# *PPEST*

## *Issues – Paving Joints*





# *PPEST*

## *Issues – Appurtenances*



# *Special Treatment SAMI (PPEST/RCS)*

## *- Tack Coat*



# *Special Treatment SAMI (PPEST/RCS)*

## *- Paving*





# *Rhode Island Use of Terminal Blended Crumb Rubber Asphalt*

## Crumb Rubber

1] Crack Seal:	
1998-2005 – General Roads	1290 tons
1999-2005 – Limited Access Highways	125 tons
2] Chip Seal: Rubber Asphalt Chip Seal	
1999-2005 – General Roads	890 tons
3] Paver Placed Elastomeric Surface Treatment	
2001-2005	155 tons
Total	2460 tons

# *Questions*

