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

<table>
<thead>
<tr>
<th>Category</th>
<th>RI</th>
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<td>Area (Thousand sq. mi.)</td>
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<tr>
<td>Population (Million)</td>
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<td>Daily VMT (Million)</td>
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<tr>
<td>All Road Miles (Thousand)</td>
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<td>SHA</td>
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<td>Other</td>
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<td><strong>SHA ROADS</strong></td>
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<tr>
<td>Miles (Thousand)</td>
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<td>Lane Miles (Thousand)</td>
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<tr>
<td>Daily VMT (Million)</td>
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<td><strong>BRIDGES</strong></td>
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<tr>
<td>Total Bridges</td>
<td>773</td>
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<td>Deficient Bridges (%)</td>
<td>24</td>
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<td>SHA Bridges</td>
<td>603</td>
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<tr>
<td>SHA Bridges (%)</td>
<td>60</td>
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<td><strong>STATE FUNDING ($Million)</strong></td>
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<td>Total (RIDOT)</td>
<td>677</td>
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<td>Capital Outlay (Pavement)</td>
<td>68</td>
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<td>Maintenance (Pavt. Preserv.)</td>
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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 ¼”
  - 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
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

Crumb Rubber Without Chemical Linking Agent

Crumb Rubber With Chemical Linking Agent
PG ASPHALT & CMCRA
The PG grading system is based on Climate

PG 64-22

Performance Grade

Meets all requirements up to this temperature (°C)

Meets all requirements down to this temperature (°C)

Meets all Engineering Requirements
# Performance Grades M320 Table

<table>
<thead>
<tr>
<th>Avg 7-day Max, °C</th>
<th>PG 46</th>
<th>PG 52</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
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<td>1-day Min, °C</td>
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**ORIGINAL**

- **Flash Point (FP)**
- **Rotational Viscosity (RV)**
- **Dynamic Shear Rheometer (DSR)**
  - \( G^* \sin \delta \)

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<thead>
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<th>( \geq 230 , ^\circ C )</th>
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<td>( \leq 3 , \text{Pa}\cdot\text{s} ) @ ( 135 , ^\circ C )</td>
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<td>( \geq 1.00 , \text{kPa} )</td>
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**ROLLING THIN FILM OVEN (RTFO)**

**Mass Loss \( \leq 1.00 \% \)**

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**PRESSURE AGING VESSEL (PAV)**

- **20 Hours, 2.07 MPa**
- **Dynamic Shear Rheometer (DSR)**
  - \( G^* \sin \delta \)

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<thead>
<tr>
<th>( \leq 5000 , \text{kPa} )</th>
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- **Bending Beam Rheometer (BBR)**
  - “S” Stiffness & “m”-value

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<th>( S \leq 300 , \text{MPa} ) &amp; ( m \geq 0.300 )</th>
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**Report Value**

- **Direct Tension (DT)**

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<td>Performance Grade</td>
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<tr>
<td></td>
<td>10</td>
<td>16</td>
<td>22</td>
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<td><strong>Climatic Conditions</strong></td>
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<td>Average 7-day maximum pavement design temperature °C</td>
<td>&lt; -64</td>
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<td>Minimum pavement design temperature °C</td>
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<td>Dynamic shear, T315: (G'\sin\delta), minimum 1.0 kPa, test temp @ 10 rad/s, °C</td>
<td>64</td>
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<td>Mass change, maximum, %</td>
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<td>PAV ageing temperature</td>
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<td>-18</td>
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PG Grading - Examples

RI
PG 64-22

FL
PG 70-18

AK
PG 52-34

Desert
PG 82-28

Temperature (°C)
Crumb Rubber Asphalt – PG Grades

Continuous or True PG grades for neat asphalt & its CMCRA

<table>
<thead>
<tr>
<th>CR %</th>
<th>0</th>
<th>3</th>
<th>5</th>
<th>6.5</th>
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<td>54-34</td>
<td>61-35</td>
<td>66-36</td>
<td>71-37</td>
<td>78-38</td>
</tr>
</tbody>
</table>

Temperature, °C
Neat Asphalt, CMCRA 1, CMCRA II, CMCRA III, CMCRA IV

Continuous or True PG grades for neat asphalt & its CMCRA
Crumb Rubber Asphalt
— Elastic Recovery and Separation

Elastic recovery of neat asphalt & its CMCRA @ 4°C+

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
Pavement Preservation Program (P³) 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

Type A
Block Sealant
Crack Sealing

Block Sealer — Failure @ 3-4 Years

Type A
Block Sealant
Crack Sealing

CMCRA — Performance @ 3 Years

Type B
CMCRA/F Sealant
• RIDOT Crack Seal Usage (2014 – 2018):
  – 16,333,500 Linear Ft by 2” wide by 3/16” high
  – 757 tons of crumb rubber
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 ± 3
- Aggregate Size – ¼” to ½” (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.

Before
Rubberized Asphalt Chip Seal — Unique Applications

Pound Hill Rd.

After
20 Years Later

Pound Hill Rd.
Rubberized Asphalt Chip Seal — Unique Applications

Concrete Pavement

Before

After
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
• RIDOT RCS usage over 5 years:
  – 1,500,000 square yards @ 0.6 gal containing 20% rubber
  – 750 tons of crumb rubber
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 ≥ 70% @ 4°C
- Aggregate – Maximum size ½”
- Marshall Mix Design – Stability 1000 lbs, Flow 8-16
Paver-Placed Elastomeric Surface Treatment — Before
Paver-Placed Elastomeric Surface Treatment — After

Detail.
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
Questions