


Ground Asphalt for Roads

Using Recycled Content Materials in Road & Infrastructure Projects Virtual Workshop

November 16, 2020

MaineDOT asphalt facts

- 8800 miles of roads
- 1M tons asphalt/year
  - 2019 avg. cost - $120/ton
- Typical pavement life: 10 years

Why recycle asphalt?

- Minimize environmental impact
- Reduced energy consumption
- Require fewer natural resources
- Reduced emissions
- Long lasting performance
- Cost effective

US Asphalt recycling – 2019*

- **89.2 Million Tons** reclaimed asphalt pavement (RAP) used
- **94%** of asphalt removed from projects was recycled
- **921,000 Tons** of recycled asphalt shingles (RAS)
- **24 Million Barrels** of virgin asphalt binder saved
- **2.4 Million Metric Tons** less CO_2 generated

*National Asphalt Pavement Association

Asphalt recycling applications

- New asphalt mixture production
  - Reclaimed Asphalt Pavement (RAP)
  - Reclaimed Asphalt Shingles (RAS)
- In-place recycling
  - Cold In-place, Hot In-place, or Full Depth
- Cold Central Plant Recycling
  - Plant Mixed Recycled Asphalt Pavement (PMRAP)

What's asphalt pavement made of anyway?

Coarse and fine aggregate

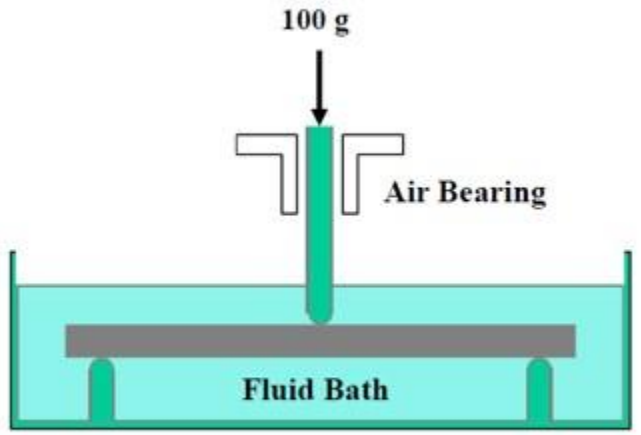
Different gradings based on intended use: 19mm, 12.5mm, 9.5mm

Asphalt binder

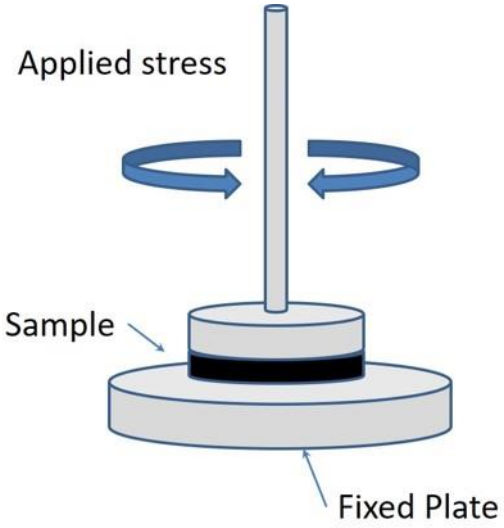
- The glue that holds it all together
- Refined from crude oil
- Viscoelastic – flows at higher temps
- The most costly component
- Typically 5% - 7% of mixture
  - Reduced by % from RAP

Asphalt binder

- Performance Grading system – we need asphalt that is:
  - Flexible at low temps – resist cracking
  - Stiff at high temps – resist rutting
- Grade selected for local traffic and climate
- Asphalt stiffens over time due to oxidation
  - Exposure to heat and air



0°C to -36°C



Asphalt mix production

- Aggregates and recycled material proportioned, blended
- Heated to remove moisture and reach mixing temperature
  - +/- 300°F
- 1.5 to 2 gal. of fuel/ton
- Mixed w/Binder and ready for transport

Trucks loaded and delivered to paver

Asphalt placement and compaction

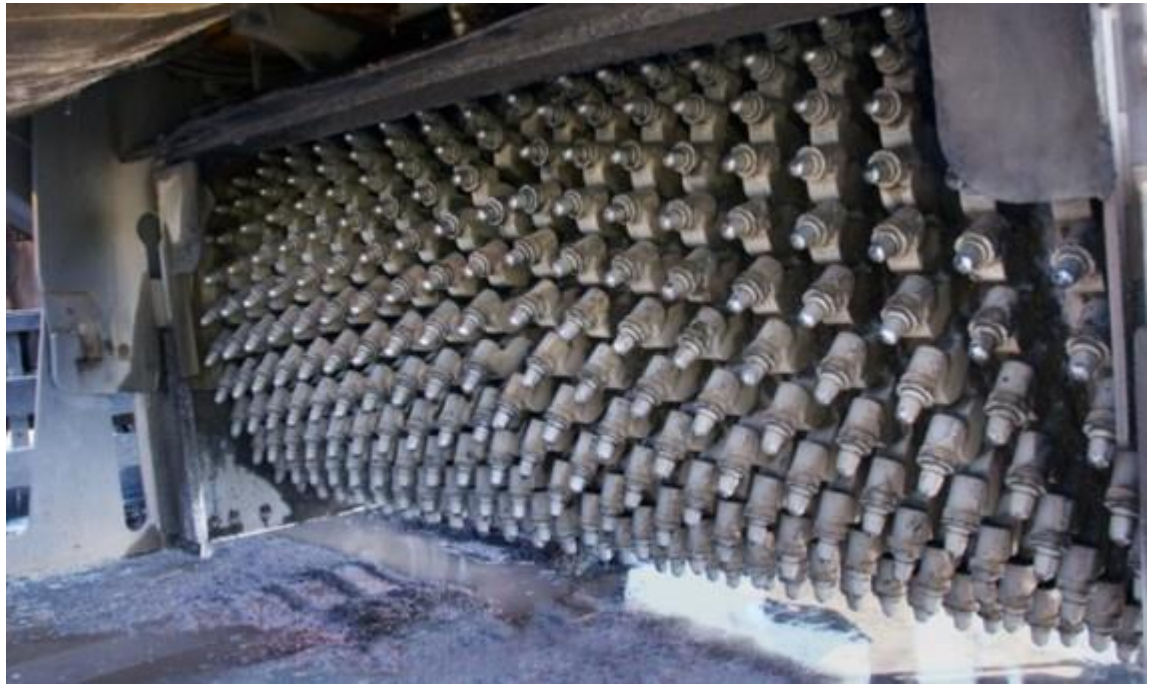
Reclaimed asphalt pavement (RAP)

- Typically generated by milling existing pavements
- Contains 3% to 6% asphalt plus aggregate
- Asphalt is stiffer due to oxidation
  - Good rut resistance, but less crack resistant
- Maine limits RAP content in new hot mix to 30%
  - % allowed based on consistency of RAP; 3 Classes
  - Usually 15% to 20%
- Also used in Cold Central Plant Recycling

Sources of RAP

- Milling existing pavements during rehabilitation
- Excavation of paved roads/parking lots/driveways, etc.
- Asphalt plant waste

Pavement milling



RAP – before processing

RAP from excavation

Millings from roadway

RAP – after crushing & screening

- Sized for inclusion in all mix gradings
- Improved consistency
- Consistent material flow during plant production

MaineDOT RAP specification

Table 1: Maximum Percent RAP According to Test Results

Classification	Maximum RAP Percentage Allowed	Asphalt content standard deviation	Percent passing 0.075 mm sieve standard deviation	Percent passing 0.075 mm sieve / asphalt content ratio	Residual aggregate M-D loss value
Class III	10%	≤ 1.0	N/A	≤ 4.0	≤ 18
Class II	20%	≤ 0.5	≤ 1.0	≤ 2.5	
Class I	30%	≤ 0.3	≤ 0.5	≤ 1.7	

Reclaimed asphalt shingles (RAS)

Reclaimed asphalt shingles (RAS)

- Generated from tear-off shingles
- Other material removed – wood, nails, etc.
- Contains 20 - 25% asphalt; some fine aggregate
  - Asphalt not “effective” – doesn’t flow even at 400° F
  - Highly oxidized due to sun/heat exposure
- Maine limits to 3% - used in maintenance paving only
  - Have experienced pavement failures

Grinding shingles to create RAS

RAS specifications

- Each load must include a Bill of Lading (unless pre-consumer waste)
  - Name of processing facility
  - Date shipped
  - Certified test results indicating no asbestos
  - Name, address of sampler and testing lab
- RAS typically mixed with RAP or sand before introducing into plant

NHDOT RAS experiment

- Recovered some asphalt from recycled shingles
- Placed in a tin with new asphalt binder
- Heated in oven at 400 F
- RAS asphalt did not flow
- After cooling, RAS asphalt cracked when tin bent – new binder remained flexible

Failures related to RAS use

In-place recycling

In-place recycling

- Advantages
  - Utilizes higher percent of reclaimed material – often 100%
  - Reduces/eliminates transport of material
  - Reduces energy and emissions versus reconstruction
  - Corrects distresses that paving cannot fix
- Limitations
  - Not applicable to all projects
  - Sometimes requires out-of-state contractors

Cold In-place Recycling

Cold In-place Recycling

- Partial depth repair: 3” – 5” typical
- Corrects surface oxidation, rutting and cracking
- Creates a stress-absorbing layer; reduces reflective cracks
- Needs lots of real estate – long equipment train
- Out-of-state contractors

Finished product before applying surface layer

Hot In-place Recycling

Hot In-place Recycling

- Treats top 1.5” of existing asphalt pavement
- Corrects minor rutting, cracking, oxidation
- Introduces a rejuvenating agent into the mixture
- Surfaced with a layer of new asphalt


330.0
°F

Full-depth Recycling

FDR process

- Pulverizes entire asphalt layer plus 2” – 3” into granular base
- Allows reshaping of roadway profile and cross-slope
- Eliminates existing ruts, cracks
- Treated with stabilizing agent:
  - Emulsified asphalt
  - Foamed asphalt
  - Cement

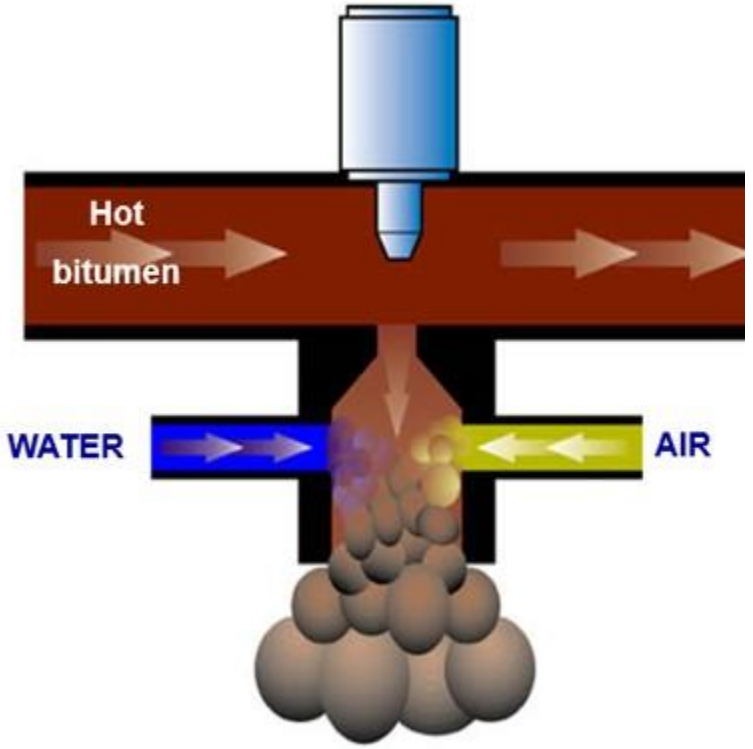
Typical candidate for FDR

FDR process

Pulverized pavement

Spreading cement

Emulsified asphalt



Foamed asphalt

Cement stabilization

FDR finished product

Cold Central Plant Recycling

Cold Central Plant Recycling

- 100% RAP
- 2% - 3% emulsified asphalt; 1% cement
- Cold process – no drying or heating
- Surface with a layer of new asphalt
- Costs much less than new asphalt mix
- MaineDOT produces the material – reduces cost
- Average 65,000 tons/year

Where is PMRP used?

1st Layer of asphalt over gravel base

Where is PMRP used?

Structural leveling course over existing pavement

Example of Material & Finished Product

Future efforts

- Working with paving association to increase RAP usage
  - Specification changes
  - Performance testing
- Exploring use of rejuvenating agents
- Monitoring action on other recycled materials
  - Plastic
  - Glass
  - Lignin

Closing thoughts

- MaineDOT successfully recycling asphalt for 30+ years
  - Always learning
- Need to select the right technology for conditions: hot mix, cold mix, in-place
- Must consider long-term performance
- Recycled pavements need to be engineered – no “linear landfills”

For more information

Rick Bradbury
Maine Department of Transportation
(207) 624-3482
Richard.Bradbury@maine.gov