HMA w/Crumb Rubber
Elmore Rd. Construction 2007
(A partnered job)

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Why HMA with Crumb Rubber?
- It costs more initially, but the mix with crumb rubber on A -C streets (between 15th and Fireweed) was placed in 1985 (22 years ago)
- For projects developed for pavement rehabilitation, the pavement surface course is approx. 38% of the total project contract cost.
- Typically construction on these roads have;
  - high traffic volumes (high traffic control $)
  - Night paving requirements

Cost Overview
- Normal HMA made from local aggregates, unmodified asphalt cement = $65 / ton, 5 year life (large plastic deformation in heavy city traffic)
- Superpave designed HMA, local aggregates, polymer modified asphalt cement = $76 / ton, 8 year life (no plastic deformation, more larger aggregate in mix)
- Superpave with “hard aggregate” and polymer modified AC = $106 / ton, 12-15 year life
- HMA with crumb rubber, polymer modified AC = $106/ t, 20 year life
Cost Analysis

- Assume a project with 10,000 tons HMA & HMA surface course = 38% of project cost.
- Normal HMA = $1.7 million project / 5 years = $340,000 / year
- Superpave HMA = $2.0 million / 8 years = $249,000 / year
- Hard Aggregate HMA = $2.8 million / 15 years = $185,000 / year
- CR HMA = $2.8 million / 20 years = $138,000 / year

Previous Rubber Mix Projects

- 1981 Upper Huffman Road
- 1985 Seward Highway Rehab.
- 1985 A-C Couplet (Still in place)
- 1986 Minnesota Extension

Mix Properties

- A-C Couplet Plus Ride
  - Local crushed aggregates.
  - AC-5, Neat AC (7.5% Optimum by weight of mix)
  - Crumb Rubber, Coarse approx. -1/4” x #16
  - 20% Buffings #20 (2.5% total combined Crumb Rubber + Buffings by weight of mix)

- Abbott Loop Extension HMA VR
  - Local Crushed Aggregates with more fracture & cubicle shape.
  - PG 64-34 Polymer Modified Asphalt Modified Cement (6.9% Optimum by weight of mix)
  - 100% Crumb Rubber -1/4” #10 (2.0% by weight of mix)
#1 Elmore Rd.
#2 AC Couplet

Marshall Mix Properties

Mix Volumes
Acceptance Testing of Mix

- 1985
- Solvent Extraction
  AASHTO T164
- AC Content
- Rubber Content
  (separated by skimming off rubber floating on the solvent)
- Aggregate Sample for Gradation

- 2007
- Ignition “Extraction”
  AASHTO T308
- AC Content (AC and Rubber burned off in process)
- Aggregate Sample for Gradation

Solvent Extraction, Vacuum
AASHTO T164

Difficult to use with mixes that contain polymer modified oil, tends to plug the filters.
Ignition, AASHTO T308

Aggregate Testing- Nordic Abrasion

Studded Tire Simulation, Prall Test
Nordic Aggregate & Prall Mix Data

- PlusRide: Nordic = 12, Prall = 13
- Type II: Nordic = 12, Prall = 40-50
- SMA: Nordic = 12, Prall = 25-40
- Hard Aggr.: Nordic = 6-8, Prall = 20
- Type R: Nordic = 12, Prall = 8

Liquid Asphalt Testing

- 1986: Viscosity Grading AC – 5
- 2007: Performance Grading PG 64-34 (polymer modified)
- Softening Point (ASTM D36)
- Toughness & Tenacity (ASTM D5801)
- Info test: Multiple Stress Creep Recovery (AASHTO TP70)
AASHTO TP70 Multiple Stress Creep Recovery

Utilizes same sample that determines G’/tanδ on RTFO sequence of binder acceptance testing. AASHTO T315
Asphalt Cements, Neat vs. Polymer Modified

MSCR Comparison

PG 52-28 ——— PG 64-34 ——— PG 70-34TR

Crumb Tire Rubber Hot Mix Asphalt

The perspective of the contractor materials guy

OVERVIEW

- Pre & Post Bid Considerations
- Crumb Tire Rubber Manufacturing
- Mix Design Concerns
- Process Control and Acceptance Testing Concerns
- Plant Modifications
- Test Strip Learning Curve
- Full Production
- Observations

Pre & Post Bid

- Bid during construction season
- Interpreting section 409
- PG 70-34, w/ 3% -#50 mesh granulated tire rubber
- Aggregate properties
- Crumb rubber properties
- Mix design, production, laying down
- Putting a cost to make it work
Western Rubber Co.: truck tires separated from light truck and car tires in receiving-initial processing yard

First steps - rip rim beads from tires, split in halves using a giant bagel slicer and stacked for processing. Very labor intensive production.

Shredding operation, two shredders process tire halves down to ± 3 x 8 inch chunks.
The significant portion of processing recycled tire rubber at the finishing facility is geared toward removing the fiberglass & steel belting, stones, nails and debris. It is accomplished while reducing particle size.

Separation process is accomplished using a number of means and methods including magnets, air circulation, vibration, jigging tables and gravity.

The processing continues right up to sacking the crumb rubber. The final separation process uses air flow which also cools the material.
Crumb Rubber Mix Ingredients - Proportions & Production

- Coarse Aggregate 46%
- Intermediate Aggregate 14%
- Crushed Fine Aggregate 36%
- Blend sand 4%
- Asphalt Cement, PG 64-34 7.2%
  revised to 6.9%
- Crumb Rubber 2%
- Double Fractured Face 99% (spec’ >98%)
- Flat Elongated @ 1:3 7% (spec’ <8%)

Plant Modifications, include a RAP feeder system which is used to meter crumb rubber into the plant weigh hopper as an aggregate.
Conveyor to aggregate weigh hopper: plant computer calls for 200 lbs. rubber per five-ton batch

Asphalt Batch Plant Production
Five-Ton Batch Weights in Sequence

- **Batch Weights:**
  - Bin 3, -3/4"+1/2" 3,500 lbs
  - Bin 2, -1/2"+ 3/16" 2,320 lbs
  - Crumb Rubber 200 lbs
  - Bin 1, -3/16" 3,290 lbs
  - Asphalt Cement 690 lbs
- **Total Batch Weight:** 10,000 lbs
- **Mix Time:**
  - Dry 15 seconds
  - Wet 30 seconds

Note: This is a revised sequence.

Test Strip Challenges & Solutions
Initial Takeoff (looks good so far)
Dialing in: temperature, thickness, observers.

Greasy Challenge!!!!

Partnering
The smell of the asphalt, the roar of the crowd …

2nd pass of test strip: partnered plan to make plant production adjustments underway

2nd pass of test strip: no wet areas, developing rolling pattern, collecting test samples
Underway, full production

Checkin’ it out.

South end of project: 3-inch lift
Big Dynapac as breakdown roller on first full production day

First day’s production looked good: no greasy spots, density good, test results good

Observations

- Our test strip temps. were too high; did not need mix design temps on grade for compaction.
- Based on our experience of three days of production, 2-inch lifts offer opportunity for a smoother ride.
- The mix is wet, greasy and tough to make representative splits; smaller on-grade samples are more representative.
- When liquid asphalt wet spots are present, it means inadequate rubber in mix.
- Still things to learn about lift thickness, rolling train and ride.
- It’s a good product I embrace; still some bugs to work out of the overall system.
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<thead>
<tr>
<th>Project Engineer’s Comment</th>
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<tbody>
<tr>
<td>- Test Strip</td>
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<tr>
<td>- 1st good</td>
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<td>- 2nd rubber deficiency, flushing, milling difficulties</td>
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<tr>
<td>- Laydown</td>
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<td>- Truck Haul (cleaning station),</td>
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<td>- Compaction</td>
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<tr>
<td>- thickness change - loose to compacted then 3” to 2”</td>
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<td>- Lateral spread</td>
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<td>- Takeoff procedures</td>
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<td>- Raking – hard, segregates easily, bumping joints</td>
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<tr>
<td>- Smoothness 3” with curb &amp; 2” without</td>
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<tr>
<td>- Mix &amp; AC quantity measurement</td>
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<td>- Opening to traffic</td>
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<tr>
<td>- Overview, Mix toughness (bob cat turning does not scuff)</td>
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<td>- Housekeeping, truck cleaning stations, monitor haul routes</td>
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