HMA w/Crumb Rubber

Elmore Rd. Construction 2007
(A partnered job)

Jeff Schrock - Wilder Construction, Proj Supt.
Greg Davis – Wilder Construction Paving Supt.
Steve Dombrowski – Wilder Quality Control Mgr.
Mike Gault – DOT/PF, Project Engr

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, 5year (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 year = $185,000 / year
- CR HMA = $2.8 million / 20 year = $138,000 / year

Previous Rubber Mix Projects

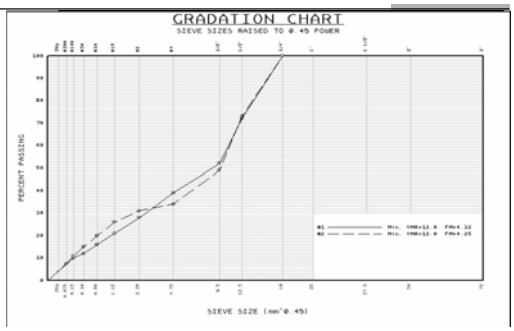
- 1981 Upper Huffman Road
- 1985 Seward Highway Rehab.
- 1985 A-C Couplet (Still in place)
- 1986 Minnesota Extension

Mix Properties

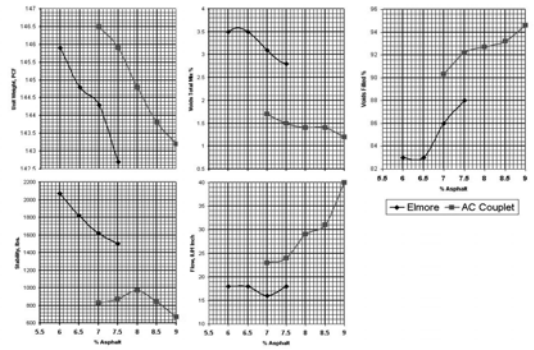
- **A-C Couplet Plus Ride**
- Local crushed aggregates.
- AC-5, Neat AC (7.5% Optimum by weight of mix)
- Crumb Rubber, Coarse approx. -1/4" x #16
- 20% Buffings -#20 (2.5% total combined Crumb Rubber + Buffings by weight of mix)

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

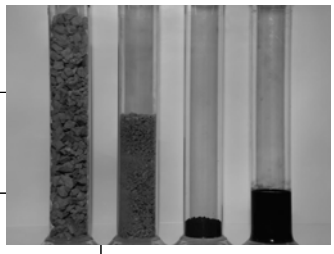
#1 Elmore Rd.
#2 AC Couplet

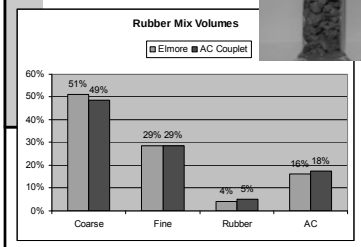


Marshall Mix Properties

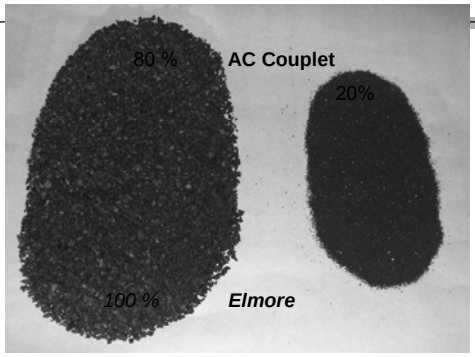


Mix Volumes





Crumb Rubber



Acceptance Testing of Mix

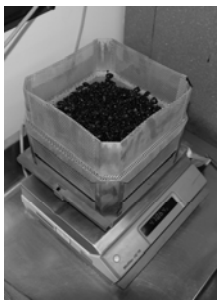
- 1985
- Solvent Extraction AASHTO T164
- AC Content
- Rubber Content (separated by skimming off rubber floating on the solvent)
- Aggregate Sample for Gradation

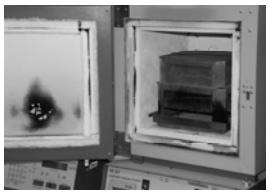
- 2007
- Ignition "Extraction" AASHTO T308
- AC Content (AC and Rubber burned off in process)
- Aggregate Sample for Gradation

Solvent Extraction, Vacuum AASHTO T164

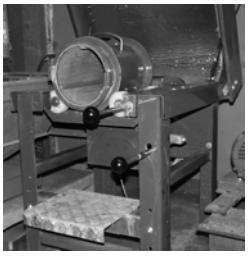
Difficult to use with mixes that contain polymer modified oil, tends to plug the filters.

Ignition, AASHTO T308

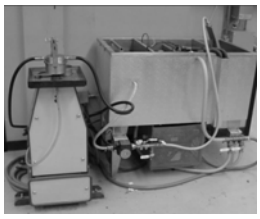


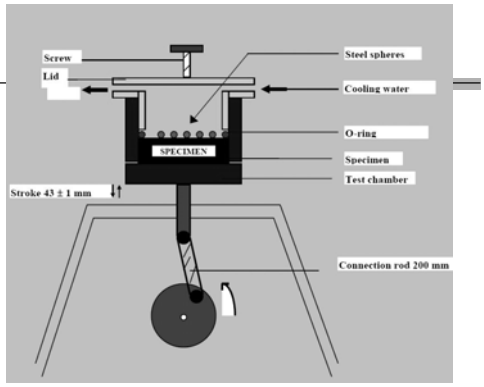


Aggregate Testing- Nordic Abrasion



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

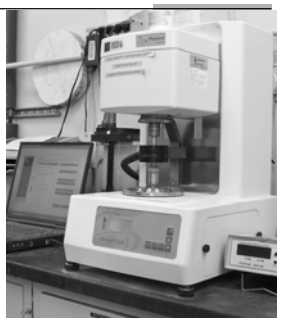
Liquid Asphalt Testing

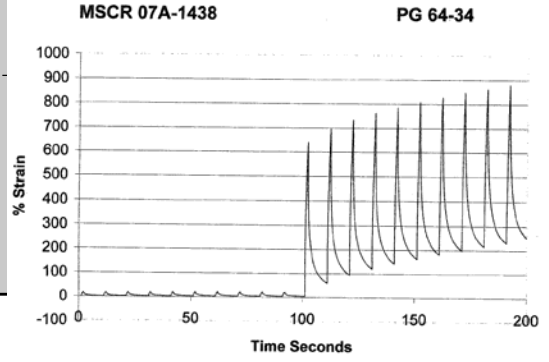
- 1986: Viscosity Grading AC – 5
- 2007: Performance Grading PG 64-34 (polymer modified)
- Softening Point (ASTM D36)
- Toughness & Tenacity (ASTM D5801)
- Info test: Multiple Stress Creep Recovery (AASHTO TP70)

		TEST RESULTS	SPECIFICATIONS
	Original Binder Tests		
	Specific Gravity @ 25°C	1.006	
AASHTO T228	Specific Gravity @ 15.6°C	1.010	
	lbs/gal.	8.41	
AASHTO T53	Softening Point	176	125 min
ASTM D5801	Toughness	88.1	110 in.lbs. min.
ASTM D5801	Tenacity	80.2	75 in.lbs. min.
AASHTO T316	Viscosity, 135°C Pa·s	2.2240	3 max.
AASHTO T48	Flash Point COC, °C	230+	230 min.
AASHTO T315 *	Hi-Temp. Stiffness (G*/sin δ), kPa	1.880	1.00 min.
	Phase Angle	48.9°	
	RTFO Aged Binder		
AASHTO T240	Mass Loss After, %	0.32	1.00 max.
AASHTO T315 *	Hi-Temp. Stiffness (G*/sin δ), kPa	2.410	2.20 min.
	Phase Angle	54.1°	
AASHTO TP70	MSCR, % Recovery @ 100 Pa	96.8%	
	MSCR, % Recovery @ 3200 Pa	96.3%	
AASHTO R28	**PAV Aged Binder**		
AASHTO T313 *	Int.-Temp. Stiffness (G* sin δ), kPa	928	5000 max.
	Phase Angle	60.1°	
AASHTO T313 **	Creep Stiffness		
	Normal Conditioning		
	S, MPa	206	300 max.
	m-value	0.356	0.300 min.
	Physical Hardening		
	S, MPa		
	m-value		
AASHTO T314	Direct Tension		

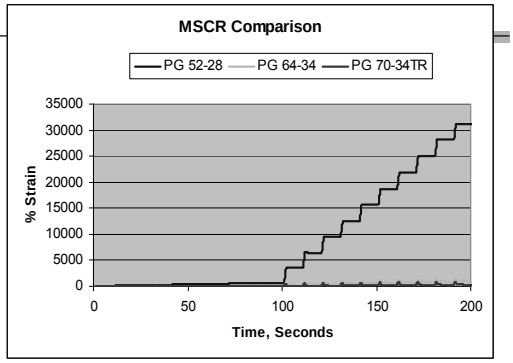
AASHTO TP70 Multiple Stress Creep Recovery

Utilizes same sample that determines G*/sinδ on RTFO sequence of binder acceptance testing. AASHTO T315





Asphalt Cements, Neat vs. Polymer Modified



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%)

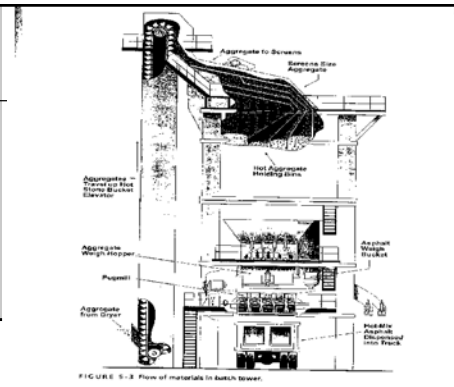


FIGURE 5-3 Flow of materials in batch tower.

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

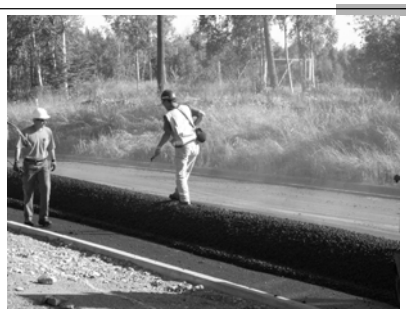
The smell of the asphalt, the roar of the crowd …

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.

Project Engineer's Comment

- Test Strip
  - 1st good
  - 2nd rubber deficiency, flushing, milling difficulties
- Laydown
  - Truck Haul (cleaning station),
  - Compaction
    - thickness change -loose to compacted then 3" to 2"
    - Lateral spread
  - Takeoff procedures
  - Raking – hard, segregates easily, bumping joints
- Smoothness 3" with curb & 2" without
- Mix & AC quantity measurement
- Opening to traffic
- Overview , Mix toughness (bob cat turning does not scuff)
- Housekeeping, truck cleaning stations, monitor haul routes