Polymer Modified Binders, Hybrid Modification

ETG Spring 2016 Meeting

April 27 – 28 , 2016, Salt Lake City, UT

Presenter:

Gaylon L. Baumgardner

Executive Vice President

Paragon Technical Services, Inc.

Jackson, MS

601-933-3217, gaylon.baumgardner@ptsilab.com

Acknowledgements

- Collaborators: Isaac Howard, Mike Hemsley, Trey Jordan, Chandra Pillai, Hari Chandra, John D'Angelo

Ergon Asphalt & Emulsions, Inc.

Mississippi State University CMRC Construction Materials Research Center An Industry, Agency & University Partnership

paragon technical services, inc.

FULL CIRCLE TECHNOLOGIES

Preliminary Comments

“Characterization and Implementation of Ground Tire Rubber as Post-Consumer Polymers for Asphalt Concrete”

- Demonstrate importance of proper processing of all types of modified bituminous binders, whether virgin synthetic, post-consumer or combinations
  - Characterize GTR using TGA
  - Improve/understand processing of GTR binders
  - Improve testing and specifications of GTR binders
  - Evaluate mixes containing GTR binders

http://gradworks.umi.com/37/37/3737185.html

Scope of Discussion/Hybrid Modification

- Dense Graded Asphalt (DGA) mixtures are the focus – a longstanding paving issue
- Terminally blended hybrid binders are discussed in this presentation
- First, present a hybrid binder specification philosophy based on virgin polymer replacement
- Second, present a few slides on a potential hybrid binder system currently available

Hybrid Binders Overview

- States acceptance/evaluation
  - Georgia
  - Florida
  - South Carolina
  - Tennessee – TDOT is considered a hybrid spec
  - Arkansas – Pulaski county is interested in hybrids
  - Nevada
  - Texas

Virgin Polymer Replacement Specification Philosophy

- Characterize GTR as a two component post-consumer polymer system (functional polymer and filler)
- Focus specification on a sustainability triple bottom line: environment, economics, and social well-being
- Learn from RAP’s progression and use this knowledge toward GTR’s implementation

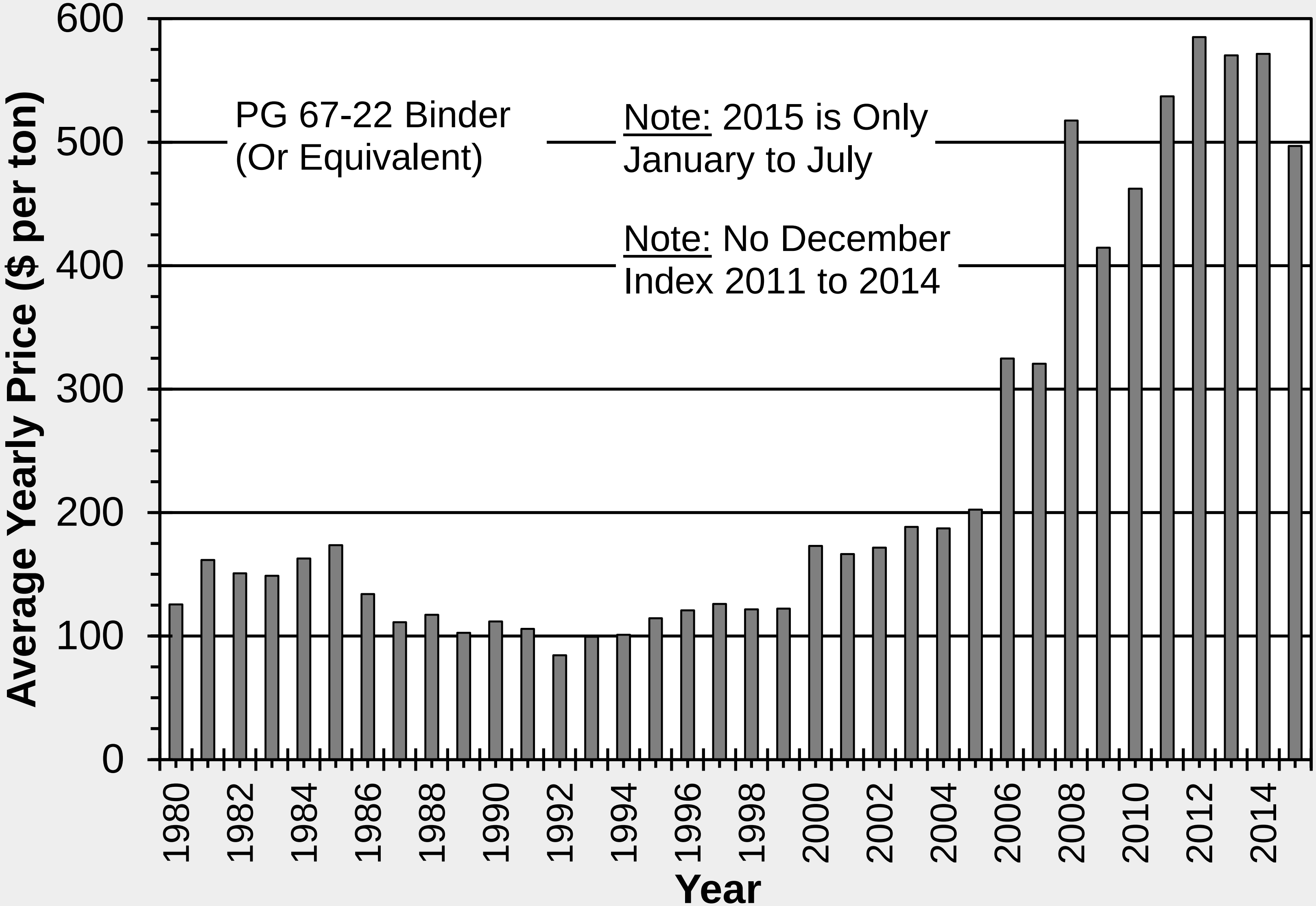
Virgin Polymer Replacement (RAP's history)

- 1970's – AC cost ↑, AC Supply ↓, RAP use ↑, few engineering limits, supply stabilized, RAP use dissipated for well over a decade
- Fast forward 3 decades or so, RAP (20%+) is accepted as a sustainable practice with acceptable performance, but there are engineering limits (e.g. virgin binder replacement)

Virgin Polymer Replacement

- Virgin replacement logic could also work for polymers
- Up front cost only, or environmental mandate only perspectives aren't as sound relative to the triple bottom line (though they are usually the FIRST considerations) – they can delay implementation
- For example:
  - modify base asphalt cement with SBS to be used in hybrid (e.g. 3% SBS)
  - Agency specified the maximum amount of SBS that can be removed (e.g. 50%)
  - Hybrid has 1.5% SBS and the amount of GTR needed to meet spec (e.g. 6%)

$ Matters –Beware Short Term Costs vs. Overall Economics



- 20-30 mesh GTR $380/ton - SBS is 6 times more expensive than GTR

Healthier Economic Perspective

- PG 76-22 prices ranged from \$90 to \$216/ton higher than PG 67-22, with an average price increase of \$138/ton over previous slide
- Use GTR to close price gap between PG 67-22 and PG 76-22 (e.g. \$138/ton) by replacing virgin polymer (e.g. SBS) with GTR. A small GTR addition (1% for example), allows a corresponding removal of SBS (e.g. 0.4%), a price per ton reduction for PG 76-22, improved sustainability, and no performance effects if the GTR is properly incorporated into the binder. GTR can continue to be incrementally added (and SBS removed) until the point asphalt binder performance suffers. At this point, price reductions can begin to negatively affect the triple bottom line.

Environmental Factors Matter

- **BUT**, beware of only looking back at the landfill and not looking forward to the pavement.
- Pavements with longer service lives that require less maintenance are more economical, and more efficiently serve public needs (e.g. less congestion due to maintenance and construction activities), which increases well-being.
- In service asphalt concrete performance affects every facet of the triple bottom line.

Ohio and South Carolina Test Sections (Nov 2015 to Feb 2016 Time Frame)

- Both used hybrid binder formulation referred to modify PG 64-22 Ergon –Memphis base binder to PG 76-22
- <u>Ohio [OH-36]:</u> 6.8% total binder, 5.8% hybrid binder, 20% RAP, 1.3 mile section, 1.5 in overlay, route with 3,000 trucks per day
- <u>South Carolina [Frontage Road]:</u> ~6.2% total binder, 5.2% hybrid binder, 23% RAP, 1.1 mile section, heavily trafficked, 1.5 in overlay

ODOT and SCDOT PG 76-22 Specs

Property	ODOT	SCDOT
T315 Phase Angle (º) - max	74	75
D5976 Separation (º F) - max	10	10
T315 Original DSR G*/sinδ (kPa) - min	1	1
T316 Rotational Viscosity (Pa-s) -max	3	3

Storage Stability with GTR is a Challenge

- **ASTM D5976:** The separation of polymer and asphalt during hot storage is evaluated by comparing the ring and ball softening point of the top and bottom portions taken from a conditioned, sealed tube of polymer-modified asphalt. The conditioning consists of placing a sealed tube of polymer modified asphalt in a vertical position in a 163$\pm$ 5°C (325 $\pm$ 10°F) oven for a 48-h period. 4^{o} F typical of typical polymer modified systems (no GTR)

Hybrid Trial Test Data

Test	Ergon – Terminal Blend	NCAT – Lab Mix	Paragon – Lab Mix
Rotational Viscosity (Pa*s)	2.16	2.01	1.88
Original DSR at 76 ^{0}C (kPa)	1.43	1.43	1.40
Phase Angle (^{o})	71.3	73.6	76.1
Separation (^{0}F)	-3.0	-2.5	-4.2

There is speculation that the Paragon sample wasn't blended long enough- 30 more minutes of blending reduced separation to under 2 ^{0}F.

Separation Data

- Separation is especially of concern for terminal blends considering fairly large volumes need mixed at a time (e.g. 18,900 gallons at Ergon – Memphis)
- South Carolina project: binder was stored in heated trailer for 21 days without agitation
- The last 6,300 gallon batch sat in tank for 4 days without agitation – no separation

Hybrid Lab Mixing Procedure

- Heat PG 64-22 to 390^{o} F and mix at high shear (3,900 rpm) in Silverson
- Blend SBS for 15 min, then add GTR for 45 minutes of mixing, add curing agent and mix for 20 more minutes

Hybrid Terminal Mixing Procedure

- Heat PG 64-22 to 387º F
- Mix SBS concentrate for 60 min @ 390º F w/ high shear mill
- Mix GTR concentrate for 90 min at 390º F w/ high shear mill
- Let down concentrate and add curing agent, use low shear mixer for 120 min at 350º F
- Observations
  - Pellets were free flowing (packaged in 1,100 lb boxes), and worked well in auger feed systems
  - Blending, dispersion, and dissolving worked well
  - Low viscosity – easy to pump
  - Hybrid binder handled and blended the same as regular polymer modified systems

Ohio and South Carolina Projects

- General observations
  - Particles didn’t stick to rollers
  - Mix wasn’t too sticky to handle
  - Unloads were clean
  - Roadways had good finish
  - Rut resistance was good
  - Used same amount of binder as regular polymer method
  - Hybrid binder was terminally blended similar to polymers, and had no meaningful storage separation

Discussion

paragon
technical services, inc.