GDOT’s Experience with Rubberized Asphalt

Marc Mastronardi, PE
Director, Division of Construction
Presentation Outline

• Hot Mix Asphalt basics

• GDOT’s use of Ground Tire Rubber (‘‘crumb rubber’’)

• I-85 Troup Project
Hot Mix Asphalt Basics

Hot mix asphalt (HMA) consists essentially of stone, sand and a binder, such as liquid asphalt cement...
Hot Mix Asphalt Design

Founded in research

Guided by AASHTO

• Marshall Method
• SuperPave
• MePDG – Mechanistic Empirical Pavement Design Guide
HMA Performance Qualities

- Rut Resistance
- Fatigue Resistance
- Temp Resistance
- Workability
- Deformation
- Skid
- Durability
- Mineral properties
- Chemical Properties
- Binder Viscosity at High Temps
- Moisture Resistance
- Air Voids
- Aggregate Angularity
- Film Thickness
Variables in HMA Design

Aggregate

- Source
- Gradation and size
- Durability/Soundness
  - Weathering
- Abrasion resistance
- Shape
- Cleanliness
Variables in HMA Design

Asphalt Binder

- Durability-
  - change over time
- Purity
- Modifiers
- Rheology-
  - deformation and flow of the binder
Superpave performance grading is reported using two numbers:

- **PG 67 – 22**
- **Performance Grade**
- **Avg 7-Day Max Pavement Temp (celsius)**
- **Min Pavement Temp (celsius)**
Lab Testing
# Job Mix Formula

## Request for Approval of Asphaltic Concrete Job Mix Formula

**Company Name:**

**Project No.:** M100000X

**County:** Clayton

**Contr. ID No.:** P12345678910/09

**PI No.:** 0000000X

**BTBuminous TSE:** John D. Asphalt

**Area Engineer:** Jane D. Construction

**District:**

**Plant Location:** Parkway Fulton County

**Person Responsible for Quality Control:**

<table>
<thead>
<tr>
<th>Type of Mix</th>
<th>Mix Design ID</th>
<th>Aggregate Size</th>
<th>Percentage</th>
<th>Source No.</th>
<th>Source Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>10111111-111-111</td>
<td>500</td>
<td>12</td>
<td>999</td>
<td>33000FKS/P</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Antistrip Additive</th>
<th>Hydrated Lime</th>
<th>Liquid A.B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Hydrated Lime Supplier: Fulton</td>
<td></td>
</tr>
</tbody>
</table>

## Mixture Data

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Mix Type</th>
<th>Mix Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1½&quot;/37.5 mm</td>
<td>1/2&quot;/25.0 mm</td>
<td>3/4&quot;/19.0 mm</td>
</tr>
<tr>
<td>1&quot;/25 mm</td>
<td>1&quot;/25 mm</td>
<td>1½&quot;/12.5 mm</td>
</tr>
<tr>
<td>3/4&quot;/19.0 mm</td>
<td>3/4&quot;/19.0 mm</td>
<td>9/16&quot;/6.35 mm</td>
</tr>
<tr>
<td>No. 4/1.75 mm</td>
<td>No. 6/2.36 mm</td>
<td>2.0</td>
</tr>
<tr>
<td>No. 8/4.76 mm</td>
<td>No. 10/3.7 mm</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent A.A.</th>
<th>Theo. Spec. Gravity (Gm)</th>
<th>Calibration Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00</td>
<td>2.047</td>
<td>0.010</td>
</tr>
</tbody>
</table>

**Approved:**

**Disapproved:**

**Remarks/Location:** Field Mix Design Verification Required

**Approved By:** John D. Asphalt

**Date:** 9/14/2018

**COPIES TO:** Area Manager, District Lab, Construction Files, Material Audit Files
Asphalt Plants
Asphalt Plants
Compaction Phases

- Primary compaction
- Aggregate movement

- Minimal additional compaction
- Smooth surface
Rubberized asphalt is also called “ground tire rubber” (GTR) asphalt. It’s a chemically reacted mix of liquid asphalt binder with a maximum of 10% of the asphalt cement (AC) coming from ground tire rubber from reclaimed tires per our Specification 820.
<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>Base Year Two-Way ADT</th>
<th>MIX TYPE</th>
<th>LAYER THICKNESS AND/OR SPREAD RATE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Minimum)</td>
<td>USE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Customary, (Metric))</td>
<td>(Maximum)</td>
</tr>
<tr>
<td>Drainage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400-3206</td>
<td>&gt;25,000</td>
<td>12.5 mm OGFC</td>
<td>85 lbs/yd², (47 kg/m³)</td>
<td>90 lbs/yd², (50 kg/m³)</td>
</tr>
<tr>
<td>400-3624</td>
<td>N/A</td>
<td>12.5 mm PEM</td>
<td>110 lbs/yd², (60 kg/m³)</td>
<td>135 lbs/yd², (75 kg/m³)</td>
</tr>
<tr>
<td>402-3814</td>
<td>&lt;800</td>
<td>4.75 mm</td>
<td>%”, 85 lbs/yd², (19 mm, 45 kg/m³)</td>
<td>7/8”, 90 lbs/yd², (22 mm, 50 kg/m³)</td>
</tr>
<tr>
<td>402-3816</td>
<td>800 to 1000</td>
<td>4.75 mm</td>
<td>1/2”, 90 lbs/yd², (22 mm, 50 kg/m³)</td>
<td>1-1/8”, 125 lbs/yd², (28 mm, 70 kg/m³)</td>
</tr>
<tr>
<td>402-3100</td>
<td>&lt;800</td>
<td>9.5 mm</td>
<td>7/8”, 90 lbs/yd², (22 mm, 50 kg/m³)</td>
<td>1-1/8”, 135 lbs/yd², (32 mm, 75 kg/m³)</td>
</tr>
<tr>
<td>402-3101</td>
<td>800 to 2000</td>
<td>Type I Superpave</td>
<td>1-1/4”, 125 lbs/yd², (28 mm, 70 kg/m³)</td>
<td>1-1/2”, 135 lbs/yd², (32 mm, 75 kg/m³)</td>
</tr>
<tr>
<td>402-3102</td>
<td>2000 to 4000</td>
<td>Type II Superpave</td>
<td>1-1/4”, 125 lbs/yd², (32 mm, 75 kg/m³)</td>
<td>1-1/2”, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
<tr>
<td>402-3103</td>
<td>4000 to 10,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>402-3130</td>
<td>10,000 to 25,000</td>
<td>12.5 mm Superpave</td>
<td>1-3/4”, 150 lbs/yd², (35mm, 80 kg/m³)</td>
<td>1-1/2”, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
<tr>
<td>402-4510</td>
<td>25,000 to 50,000</td>
<td>12.5 mm Superpave w/polymer Modified AC</td>
<td>1-3/4”, 150 lbs/yd², (35mm, 80 kg/m³)</td>
<td>1-1/2”, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
<tr>
<td>402-3600</td>
<td>&gt;50,000</td>
<td>12.5 mm SMA</td>
<td>1-1/4”, 150 lbs/yd², (35mm, 80 kg/m³)</td>
<td>1-1/2”, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
</tbody>
</table>
# CRITERIA FOR USE OF ASPHALTIC CONCRETE LAYER AND MIX TYPES

(Use Design Year Two-Way ADT and ADTT)

## Mixes Used on an Infrequent Basis (Contact OMAT for Guidance before using)

<table>
<thead>
<tr>
<th>Two-Way ADT</th>
<th>Maximum Two-Way ADTT</th>
<th>MIX TYPE</th>
<th>LAYER THICKNESS AND/OR SPREAD RATE (Minimum)</th>
<th>USE (Customary, (Metric))</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>9.5 mm OGFC</td>
<td>55 lbs/yd², (30 kg/m³)</td>
<td>60 lbs/yd², (35 kg/m³)</td>
<td>65 lbs/yd², (35 kg/m³)</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>12.5 mm PEM</td>
<td>110 lbs/yd², (60 kg/m³)</td>
<td>135 lbs/yd², (73 kg/m³)</td>
<td>165 lbs/yd², (90 kg/m³)</td>
</tr>
<tr>
<td>&lt;800</td>
<td>N/A</td>
<td>9.5 mm Type I Superpave</td>
<td>7/8&quot;, 90 lbs/yd², (22 mm, 49 kg/m³)</td>
<td>1-1/4&quot;, 135 lbs/yd², (32 mm, 73 kg/m³)</td>
<td>1-1/4&quot;, 135 lbs/yd², (32 mm, 73 kg/m³)</td>
</tr>
<tr>
<td>800 to 2,000</td>
<td>N/A</td>
<td>9.5 mm Type II Superpave w/ Polymer Modified AC</td>
<td>7/8&quot;, 90 lbs/yd², (22 mm, 49 kg/m³)</td>
<td>1-1/4&quot;, 135 lbs/yd², (32 mm, 73 kg/m³)</td>
<td>1-1/2&quot;, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>9.5 mm SMA</td>
<td>1-1/8&quot;, 125 lbs/yd², (29 mm, 68 kg/m³)</td>
<td>1-1/4&quot;, 135 lbs/yd², (32 mm, 73 kg/m³)</td>
<td>1-1/2&quot;, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
</tr>
<tr>
<td>10,000 to 50,000</td>
<td>N/A</td>
<td>12.5 mm Superpave w/ Highly Polymer Modified AC</td>
<td>1-3/8&quot;, 150 lbs/yd², (35 mm, 81 kg/m³)</td>
<td>1-1/2&quot;, 165 lbs/yd², (38 mm, 90 kg/m³)</td>
<td>2-1/2&quot;, 275 lbs/yd², (64 mm, 149 kg/m³)</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>19 mm Superpave w/ Polymer Modified AC</td>
<td>1-3/4&quot;, 190 lbs/yd², (44 mm, 103 kg/m³)</td>
<td>2&quot;, 220 lbs/yd², (50 mm, 120 kg/m³)</td>
<td>3&quot;, 330 lbs/yd², (75 mm, 180 kg/m³)</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>19 mm SMA</td>
<td>1-3/4&quot;, 190 lbs/yd², (44 mm, 103 kg/m³)</td>
<td>2&quot;, 220 lbs/yd², (50 mm, 120 kg/m³)</td>
<td>3&quot;, 330 lbs/yd², (75 mm, 180 kg/m³)</td>
</tr>
</tbody>
</table>

Note: Mix type to be used for patching and leveling will depend on thickness to be placed according to Section 400.3.03.8.4, Table 3 in Shelf Special Provision.

**Use of the shown pay items for Surface mixes will comply with GDOT Policy SS20-8 in relation to the allowed aggregate Group/Blend for friction and ADT.**
Facts and Figures

110 production plants associated with 36 paving contractors are approved by GDOT for asphalt production

~10%, or 440,000 tons of all asphalt placed last year, was designed to be polymer/GTR modified

6 of 36 asphalt paving contractors have placed rubberized asphalt in GA
Rubber Tires are Shredded and Further Processed to Reduce the Size
Incorporating GTR into the Mix

- Dry Method or Wet Method are allowed by GDOT
- Most Georgia contractors have elected to use the dry method
  - Less modification or special equipment required at each asphalt plant facility
  - Significantly less cost for plant modifications
  - Gives the contractor more freedom to produce varied asphalt mixtures requiring different asphalt cement (AC) grades.
    - Several asphalt plants only have one AC tank and the wet method could limit production.
GTR – Dry Method

GTR is added at the asphalt plant via an aggregate feed where it is mixed and heated.
Wet Method - Cement Blending System

Blended at the Terminal
(offsite large volume storage)

Blended at the Asphalt Plant
(portable tanks/tankers)
Typical Costs to Use Wet Method

If modifying the plant with fixed equipment
~ $1M to $1.5M

If utilizing portable equipment via rental
~ $45,000/month
~ $50,000 mobilization cost
GDOT Experience with GTR

A test section was placed on I-75 in Henry County and evaluated from 1991 to 1995

- GTR lay-down was difficult, *(material accumulated on tools and equipment)*
- GTR did not demonstrate reduced rutting
- GTR was twice as expensive to place when compared with *regular* hot mix asphalt (HMA)
- Two other projects were placed on US 82 in Worth county and Fulton Industrial Blvd in Atlanta that indicated similar findings
... No concentrated efforts to expand our GTR piloting occurred for several years

Then, on August 6, 2008 the Association of Modified Asphalt Producers (AMAP) issued a white paper.

“THERE IS A CURRENT SHORTAGE OF STYRENE-BUTADIENE POLYMERS FOR THE ASPHALT INDUSTRY. THE SHORTAGE INVOLVES A VARIETY OF POLYMERS, INCLUDING LINEAR AND RADIAL SBS POLYMERS, AND DIBLOCK SB POLYMERS.”
Adding Tools to the Toolbox

New GTR Asphalt Test Section in Hawkinsville, GA on SR 26
9.5 mm Superpave w/ GTR Mix Design

- AC content: 5.6%

- 10% rubber (of asphalt content), which is equivalent to 0.56% of hot mix asphalt (HMA)

- Asphalt Pavement Analyzer results = 0.19 mm (max allowed rutting in spec is 5 mm)

- Reclaimed asphalt pavement (RAP) content was 45%

- Retained Tensile strength was 80.4 %. However, the individual strength is very high

- Met all the mix design requirements of standard specifications
GTR Modified Asphalt Mix at the Plant
GTR Test Section After Placement on SR 26 in Hawkinsville

Passed all QC/QA requirements, including smoothness and density.  Hey, we’re on to something!!
Test Section on I-75 in Perry, GA (Approved by GDOT & FHWA)

Porous European Mix
2009 GTR/Crumb Rubber modified asphalt alternate specification was developed.

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION
PROJECT No.
P.I. No.

Section 820—Asphalt Cement

Delete Section 820 and substitute the following:

820.1 General Description
This Section includes the requirements for asphalt cements prepared from crude petroleum.

820.1.01 Related References
A. Standard Specifications
   General Provisions 101 through 150.
B. Referenced Documents
   Standard Operating Procedure (SOP 4)
   AASHTO R 28
   AASHTO T 48
   AASHTO T 179
   AASHTO T 240
   AASHTO T 313
   AASHTO T 314
   AASHTO T 315
   AASHTO T 316
   AASHTO TP70 (proposed) / ASTM D7405

820.2 Materials

820.2.01 Asphalt Cement
A. Requirements
   1. Type
      Use a material that is homogeneous and water-free and that does not foam when heated to 347 °F (175 °C).
      Ensure that a blend used to produce a specified performance grade meets the following requirements:
      - Is uniform and homogeneous without separation
      - Uses PG 64-22 or PG 67-22 described below for the base asphalt
      - Consists of production materials that have not been “air-blown or acid modified” to achieve the performance grade
   2. Grade
      Use the various grades of asphalt cement that meet the requirements shown in the test requirements for Petroleum Asphalt Cements
The quality of the materials are specified in Section 820.2.01.2 Grade

...crumb rubber modified PG 76-22 is an acceptable alternative to SBS or SB modified asphalt cement at contractor's discretion, provided the SBR and crumb rubber modified asphalt cement meets the test requirement's of PG 76-22
The quality of the rubber is also specified in Section 820.2.01.2 Grade

...For crumb rubber modified PG 67-22 to meet PG 76-22, use 30 mesh size ambient or cryogenic ground tire rubber at 10% of weight of total asphalt cement content. Trans-Polyoctenamer, or other approved workability additive, shall be added to the crumb rubber to achieve better particle distribution.
GTR Constructed Projects
GDOT’s use of GTR modified asphalt

~ 500,000 TONS OF RUBBER MODIFIED ASPHALT MIX HAVE BEEN PLACED ON THE FOLLOWING ROUTES AND THE NUMBER IS GROWING:


AND ALL ARE PERFORMING WELL.
I-75 Lowndes County Project – Polymer Modified Asphalt and GTR (Paved in 2010)
Reeves Construction is currently paving with GTR on I-75 in Lowndes County
Is GTR Asphalt Recyclable??

…Yes – “…The rubber particles in asphalt rubber are not digested, but remain, for the most part, undissolved and do not become volatilized, and do not contribute to toxic emissions…” , and “…measured emission rates of (crumb rubber) particulate and toxic compounds were consistently lower than the emission factors indicated in EPA’s AP-42 emission factors for asphalt plants…” (Rubber Pavement Association 2003)

In fact, Per a 2011 FHWA survey, less than 1% of ALL asphalt ends up in a landfill. It is said to be the most recycled construction product in the transportation industry. GDOT allows 40% of the mix to be reclaimed asphalt pavement (RAP).
National Research - GTR

National Center for Asphalt Technology (NCAT) Test Track, the Missouri DOT sponsored two test sections comparing a GTR modified mixture to a polymer modified mixture.

- After 10 million equivalent single axle loads (ESALs) there was no difference between the performance of these two sections.

- The polymer modified test section was removed in the summer of 2012; however, the GTR test section remained in place for another 10 million ESALs. After a total of 20 million ESALs of traffic, there was minimal rutting and no cracking found in the test section.

- Laboratory experiments also showed comparable performance between the two mixtures.
Three rubberized asphalt projects included in the research

I-75 – Perry, Georgia
I-20 – Augusta, Georgia
I-75 – Valdosta, Georgia

Findings: For all projects evaluated at the time of the research, rubberized asphalt was performing similar to the conventional polymer modified asphalt.
National Center for Asphalt Technology Auburn, AL 2018 Test Cycle – GDOT is sponsoring a test section using GTR via the wet method in “high content” (20%) as a crack mitigation process. The Track will be trafficked by trucks ~ 16 hours a day for approximately two years (20 Million ESALs)

* The section was placed on 9/4/18
I-85 Troup Resurfacing

• Final Quality Assurance review
• Additional tonnage
• Analysis to isolate the areas will push the project to the December letting with a year to construct
• Provisions were previously developed to mandate proposing contractors provide a bid for both GTR and polymer modified mixes in lieu of only one method being bid
• Technical assistance
Add the following to Subsection 102.07

K. Failure to Submit Two Bids

a. This project has an alternate version utilizing either PG76-22 or PG64-22 modified with crumb rubber to meet PG76-22 or PG67-22 modified with crumb rubber to meet PG76-22 in accordance with Section 820 – Asphalt Cement in this letting.

b. The Bidder shall prepare a responsible bid for each project for either bid to be eligible for consideration.

c. If the bidder fails to submit a bid on both projects they will be determined to be non-responsive to the advertisement and their single proposal will be rejected.
December 14, 2018 Letting

Proposal ID “XYZ1”, Harris, Troup and Proposal ID “XYZ2”, Harris, Troup share PI M004921.

Each proposal must be bid upon in order for either bid to be considered by the Department. Failure to tender a responsible bid for each proposal will result in the bidder being determined as non-responsive to the advertisement in accordance with Special Provision 102.07.K of the proposal.

Each proposal is independent of the other and shall be examined thoroughly upon its own basis.

Only one proposal will be awarded.

** Please also note technical assistance is available for GTR/Crumb Rubber construction from Liberty Tire. Please contact Doug Carlson via email at: DCarlson@libertytire.com
Questions and comments?