



Georgia Department of Transportation

# **GDOT's Experience with Rubberized Asphalt**

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# 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...**



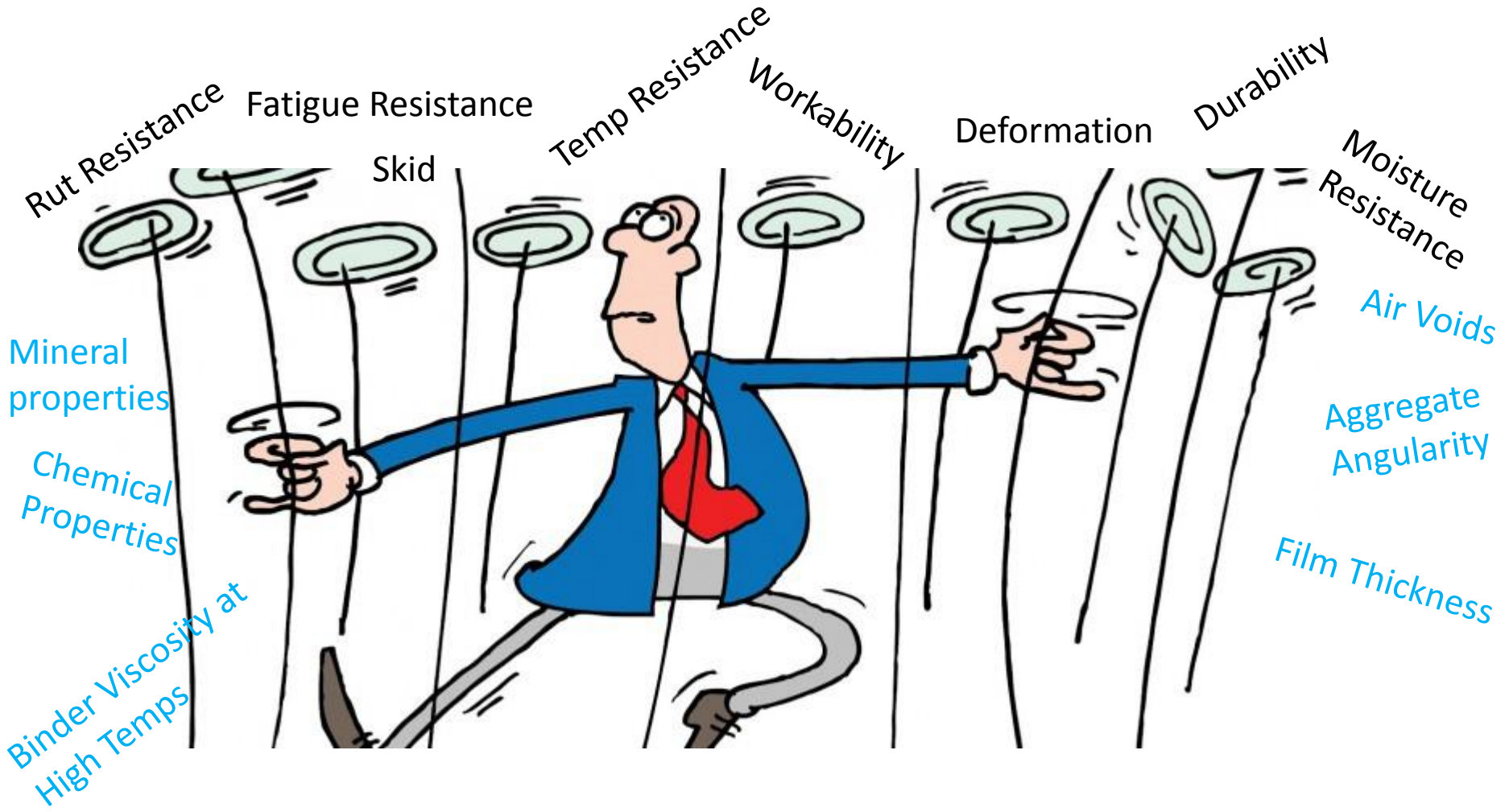
# Hot Mix Asphalt Design

**Founded in research**

**Guided by AASHTO**

- Marshall Method
- SuperPave
- MePDG – Mechanistic Empirical Pavement Design Guide

# HMA Performance Qualities



# 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

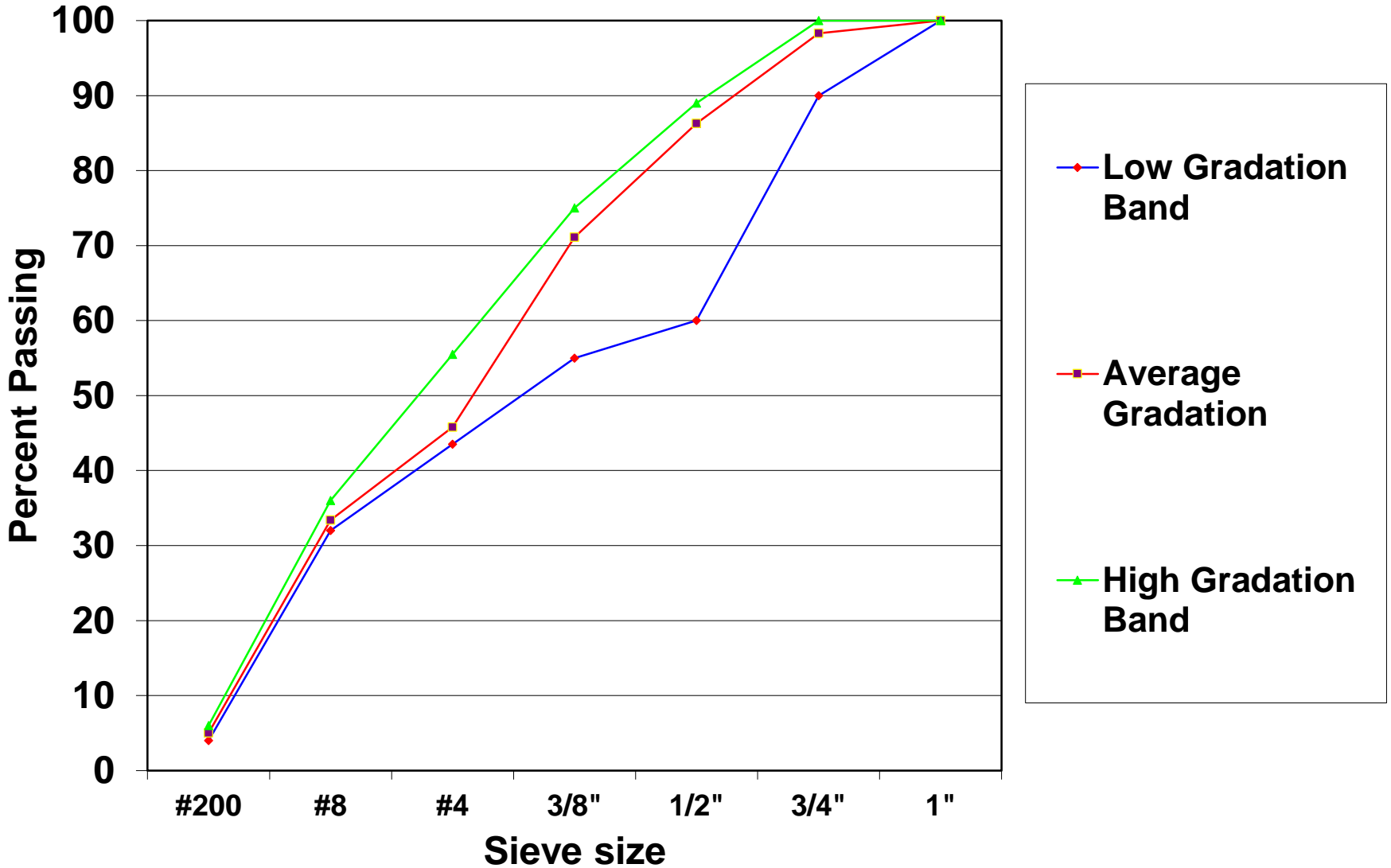






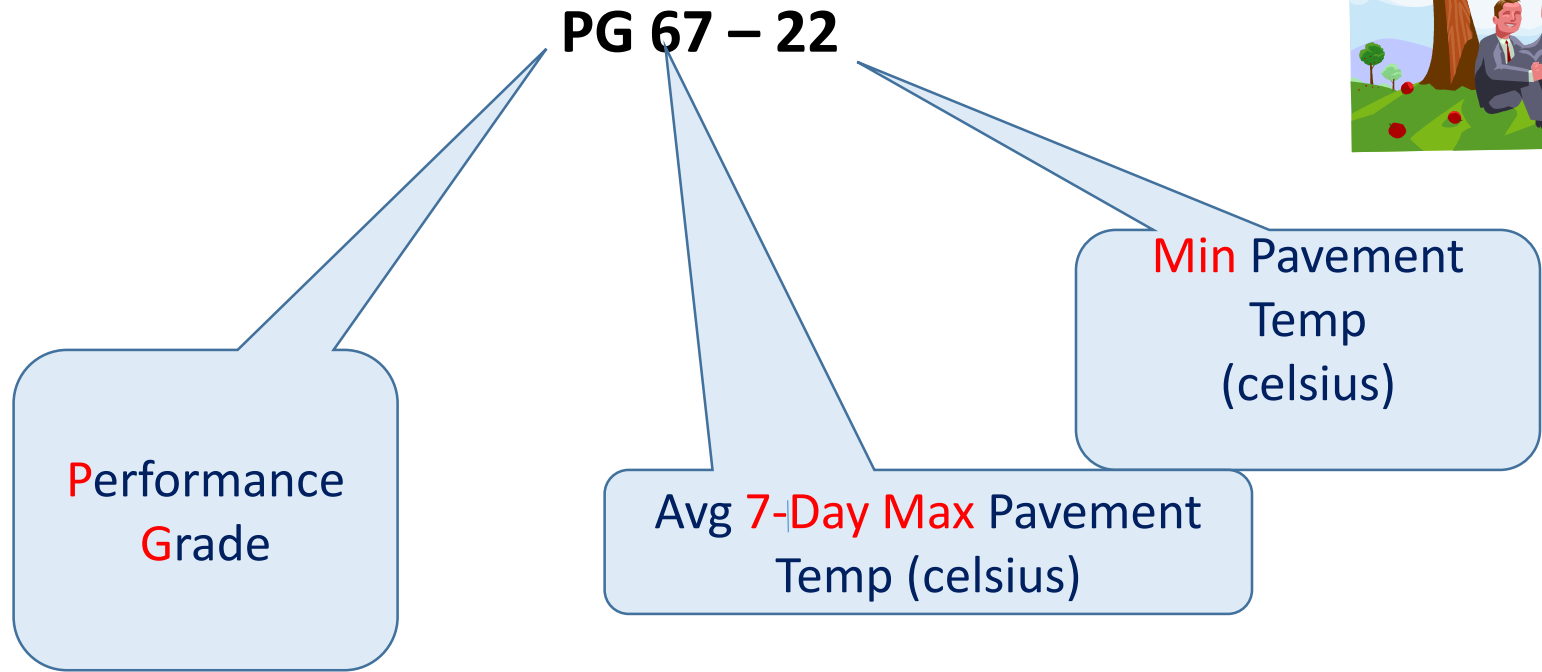


# 19 mm Superpave



# PG Asphalt Cement

Superpave performance grading is reported using two numbers :



# Lab Testing





# Asphalt Plants





# Asphalt Plants



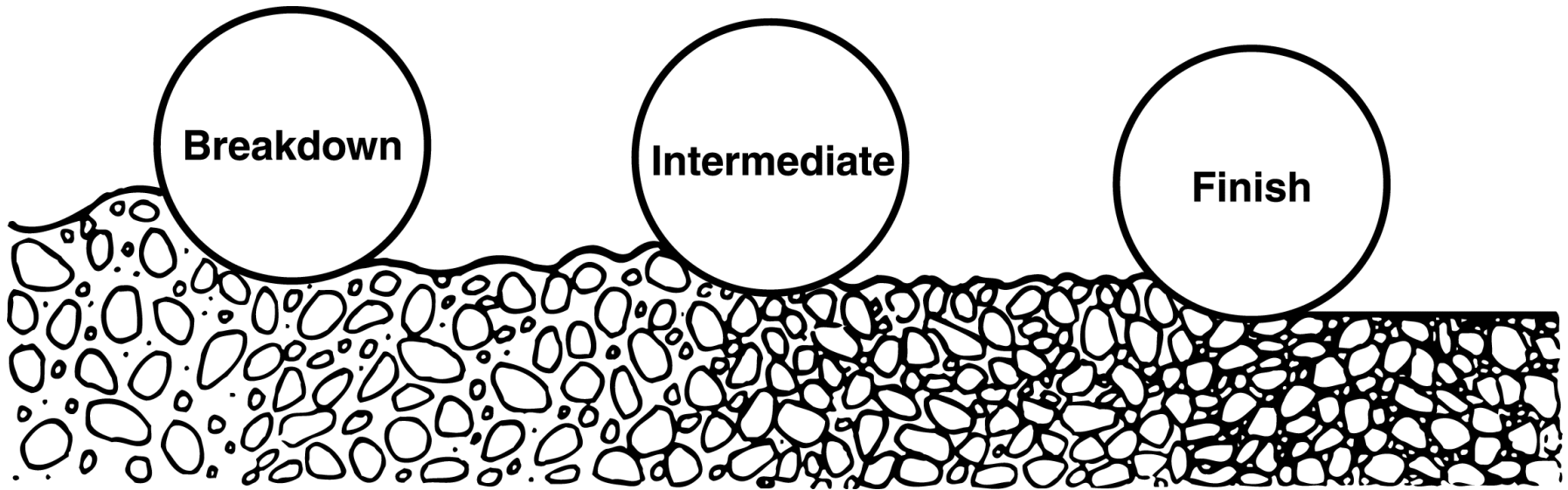








# Compaction Phases



- Primary compaction
- Aggregate movement

- Minimal additional compaction
- Smooth surface

## Rubberized Asphalt

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.



	PAY ITEM	Base Year Two-Way ADT	MIX TYPE	LAYER THICKNESS AND/OR SPREAD RATE			REMARKS
				Customary, (Metric)			
				(Minimum)	USE	(Maximum)	
Drainage	400-3206	>25,000	12.5 mm OGFC	85 lbs/yd <sup>2</sup> , (47 kg/m <sup>2</sup> )	<b>90 lbs/yd<sup>2</sup>, (50 kg/m<sup>2</sup>)</b>	95 lbs/yd <sup>2</sup> , (53 kg/m <sup>2</sup> )	For High ADT State Routes with speed limits ≥ 55 mph.
	400-3624	N/A	12.5 mm PEM	110 lbs/yd <sup>2</sup> , (60 kg/m <sup>2</sup> )	<b>135 lbs/yd<sup>2</sup>, (75 kg/m<sup>2</sup>)</b>	165 lbs/yd <sup>2</sup> , (90 kg/m <sup>2</sup> )	For Interstate Routes.
Surface**	402-3814	<800	4.75 mm	¾", 85 lbs/yd <sup>2</sup> , (19 mm, 45 kg/m <sup>2</sup> )	<b>7/8", 90 lbs/yd<sup>2</sup>, (22 mm, 50 kg/m<sup>2</sup>)</b>	1-1/8", 125 lbs/yd <sup>2</sup> , (28 mm, 70 kg/m <sup>2</sup> )	For State and Off-system Routes with low truck traffic volume (< 100 trucks per day).
	402-3816	800 to 1000					
	402-3100	<800	9.5 mm Type I Superpave	7/8", 90 lbs/yd <sup>2</sup> , (22 mm, 50 kg/m <sup>2</sup> )	<b>1-¼", 135 lbs/yd<sup>2</sup>, (32 mm, 75 kg/m<sup>2</sup>)</b>	1-½", 135 lbs/yd <sup>2</sup> , (32 mm, 75 kg/m <sup>2</sup> )	For State and Off-system Routes <b>* For Off-system Routes <u>only</u> USE: 1-1/8", 125 lbs/yd<sup>2</sup>, (28 mm, 70 kg/m<sup>2</sup>)</b>
	402-3101	800 to 2000					
	402-3102	2000 to 4000	9.5 mm Type II Superpave	1-1/8", 125 lbs/yd <sup>2</sup> , (28 mm, 70 kg/m <sup>2</sup> )	<b>1-¼", 135 lbs/yd<sup>2</sup>, (32 mm, 75 kg/m<sup>2</sup>)</b>	1-½", 165 lbs/yd <sup>2</sup> , (38 mm, 90 kg/m <sup>2</sup> )	For State and Off-system Routes.
	402-3103	4000 to 10,000					
	402-3130	10,000 to 25,000	12.5 mm Superpave	1-3/8", 150 lbs/yd <sup>2</sup> , (35mm, 80 kg/m <sup>2</sup> )	<b>1-¾", 165 lbs/yd<sup>2</sup>, (38 mm, 90 kg/m<sup>2</sup>)</b>	2-½", 275 lbs/yd <sup>2</sup> , (64 mm, 150 kg/m <sup>2</sup> )	For State Routes and for shoulders of Interstate Routes.
	402-4510	25,000 to 50,000	12.5 mm Superpave w/polymer Modified AC	1-3/8", 150 lbs/yd <sup>2</sup> , (35mm, 80 kg/m <sup>2</sup> )	<b>1-¾", 165 lbs/yd<sup>2</sup>, (38 mm, 90 kg/m<sup>2</sup>)</b>	2-½", 275 lbs/yd <sup>2</sup> , (64 mm, 150 kg/m <sup>2</sup> )	For High ADT State Routes, all Interstate Routes; and all Interstate Ramps.
	402-3600	>50,000	12.5 mm SMA	1-3/8", 150 lbs/yd <sup>2</sup> , (35mm, 80 kg/m <sup>2</sup> )	<b>1-¾", 165 lbs/yd<sup>2</sup>, (38 mm, 90 kg/m<sup>2</sup>)</b>	3", 330 lbs/yd <sup>2</sup> , (75mm, 180 kg/m <sup>2</sup> )	For Interstate Routes and for State Routes when recommended by OMR. <b>OMR may recommend 2-inch lift 12.5 mm SMA on Interstates.</b>

## 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)

Two-Way ADT	Maximum Two-Way ADTT	MIX TYPE	LAYER THICKNESS AND/OR SPREAD RATE			REMARKS
			Customary, (Metric)			
			(Minimum)	USE	(Maximum)	
N/A	N/A	9.5 mm OGFC	55 lbs/yd <sup>2</sup> , (30 kg/m <sup>2</sup> )	60 lbs/yd <sup>2</sup> , (33 kg/m <sup>2</sup> )	65 lbs/yd <sup>2</sup> , (35 kg/m <sup>2</sup> )	Limited use on State Routes to address specific drainage problems and for High ADT State Routes with speed limits ≥ 55 mph only when recommended by OMAT.
N/A	N/A	12.5 mm PEM	110 lbs/yd <sup>2</sup> , (60 kg/m <sup>2</sup> )	135 lbs/yd <sup>2</sup> , (73 kg/m <sup>2</sup> )	165 lbs/yd <sup>2</sup> , (90 kg/m <sup>2</sup> )	For Interstate Routes only when recommended by OMAT.
<800	N/A	9.5 mm Type I Superpave	7/8", 90 lbs/yd <sup>2</sup> , (22 mm, 49 kg/m <sup>2</sup> )	1-1/4**, 135 lbs/yd <sup>2</sup> , (32 mm, 73 kg/m <sup>2</sup> )	1-1/4", 135 lbs/yd <sup>2</sup> , (32 mm, 73 kg/m <sup>2</sup> )	For use on Off-System Routes.
800 to 2,000	N/A					*For Off-system Routes <u>only</u> USE: 1-1/8", 125 lbs/yd <sup>2</sup> , (29 mm, 68 kg/m <sup>2</sup> ) For use in parking lot construction. For use on State Routes only when recommended by OMAT.
N/A	N/A	9.5 mm Type II Superpave w/ Polymer Modified AC	7/8", 90 lbs/yd <sup>2</sup> , (22 mm, 49 kg/m <sup>2</sup> )	1-1/4", 135 lbs/yd <sup>2</sup> , (32 mm, 73 kg/m <sup>2</sup> )	1-1/2", 165 lbs/yd <sup>2</sup> , (38 mm, 90 kg/m <sup>2</sup> )	Only when recommended by OMAT.
10,000 to 50,000	N/A	9.5 mm SMA	1-1/8", 125 lbs/yd <sup>2</sup> , (29 mm, 68 kg/m <sup>2</sup> )	1-1/4", 135 lbs/yd <sup>2</sup> , (32 mm, 73 kg/m <sup>2</sup> )	1-1/2", 165 lbs/yd <sup>2</sup> , (38 mm, 90 kg/m <sup>2</sup> )	May be used as alternate surface on State Routes <u>only</u> when recommended by OMAT.
N/A	N/A	12.5 mm Superpave w/ Highly Polymer Modified AC	1-3/8", 150 lbs/yd <sup>2</sup> , (35 mm, 81 kg/m <sup>2</sup> )	1-1/2", 165 lbs/yd <sup>2</sup> , (38 mm, 90 kg/m <sup>2</sup> )	2-1/2", 275 lbs/yd <sup>2</sup> , (64 mm, 149 kg/m <sup>2</sup> )	May be used as alternate surface <u>only</u> when recommended by OMAT.
N/A	N/A	19 mm Superpave w/ Polymer Modified AC	1-3/4", 190 lbs/yd <sup>2</sup> , (44 mm, 103 kg/m <sup>2</sup> )	2", 220 lbs/yd <sup>2</sup> , (50 mm, 120 kg/m <sup>2</sup> )	3", 330 lbs/yd <sup>2</sup> , (75 mm, 180 kg/m <sup>2</sup> )	Only when recommended by OMAT.
N/A	N/A	19 mm SMA	1-3/4", 190 lbs/yd <sup>2</sup> , (44 mm, 103 kg/m <sup>2</sup> )	2", 220 lbs/yd <sup>2</sup> , (50 mm, 120 kg/m <sup>2</sup> )	3", 330 lbs/yd <sup>2</sup> , (75 mm, 180 kg/m <sup>2</sup> )	Only for special circumstances, with concurrence of OMAT.

Note: Mix type to be used for patching and leveling will depend on thickness to be placed according to Section 400.3.03.B.4, Table 3 in Shelf Special Provision.

\*\*Use of the shown pay items for Surface mixes will comply with GDOT Policy 5520-8 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

First Use Date: August 30, 2007  
Revised: November 03, 2008  
Revised: March 18, 2009

**DEPARTMENT OF TRANSPORTATION  
STATE OF GEORGIA**

**SPECIAL PROVISION**

**PROJECT No.**

**P.I. No.**

**Section 820—Asphalt Cement**

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*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 homogenous 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

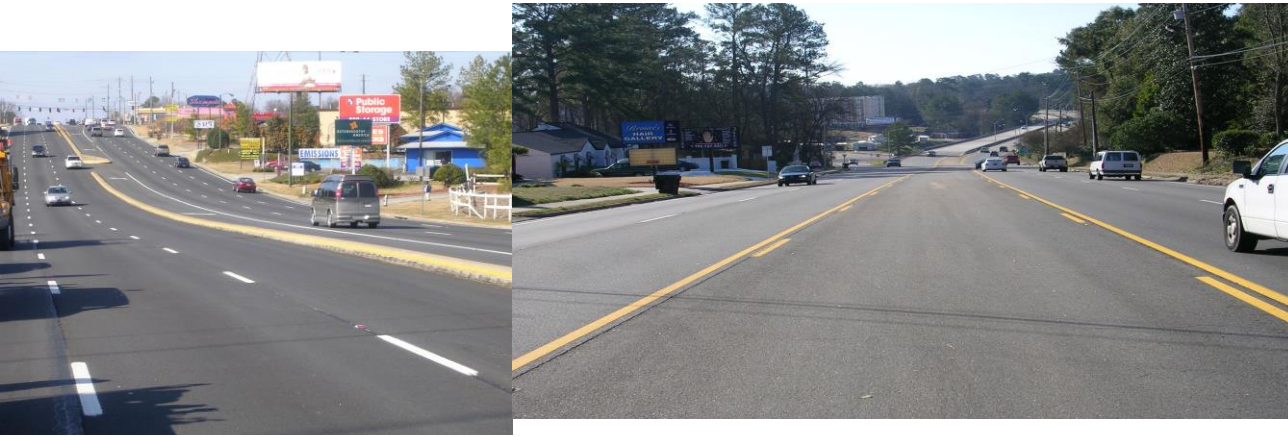
## **The quality of the materials are specified in Section 820.2.01.2 Grade**

**...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:

I-75, I-20, I-520, SR 26, SR 140, SR 9, SR 124, SR 8/US 78, SR 17, US 441, SR 28, SR 10.....

AND ALL ARE PERFORMING WELL.



# I-75 Lowndes County Project – Polymer Modified Asphalt and GTR (Paved in 2010)



PMA

GTR





# 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.**

GDOT Research Project No. 11-19

Comprehensive Evaluation of the Long-Term Performance  
of Rubberized Pavement

Phase I: Laboratory Study of Rubberized Asphalt Mix Performance

Final Report

By

Junan Shen, Ph.D.  
Associate Professor

&

Zhaoxing Xie, Ph.D.  
Postdoctoral Fellow  
Georgia Southern University

Contract with

Georgia Department of Transportation

in cooperation with

U.S. Department of Transportation  
Federal Highway Administration

December 2012

## Three rubberized asphalt projects included in the research

**I-75 – Perry, Georgia**

**I-20 – Augusta, Georgia**

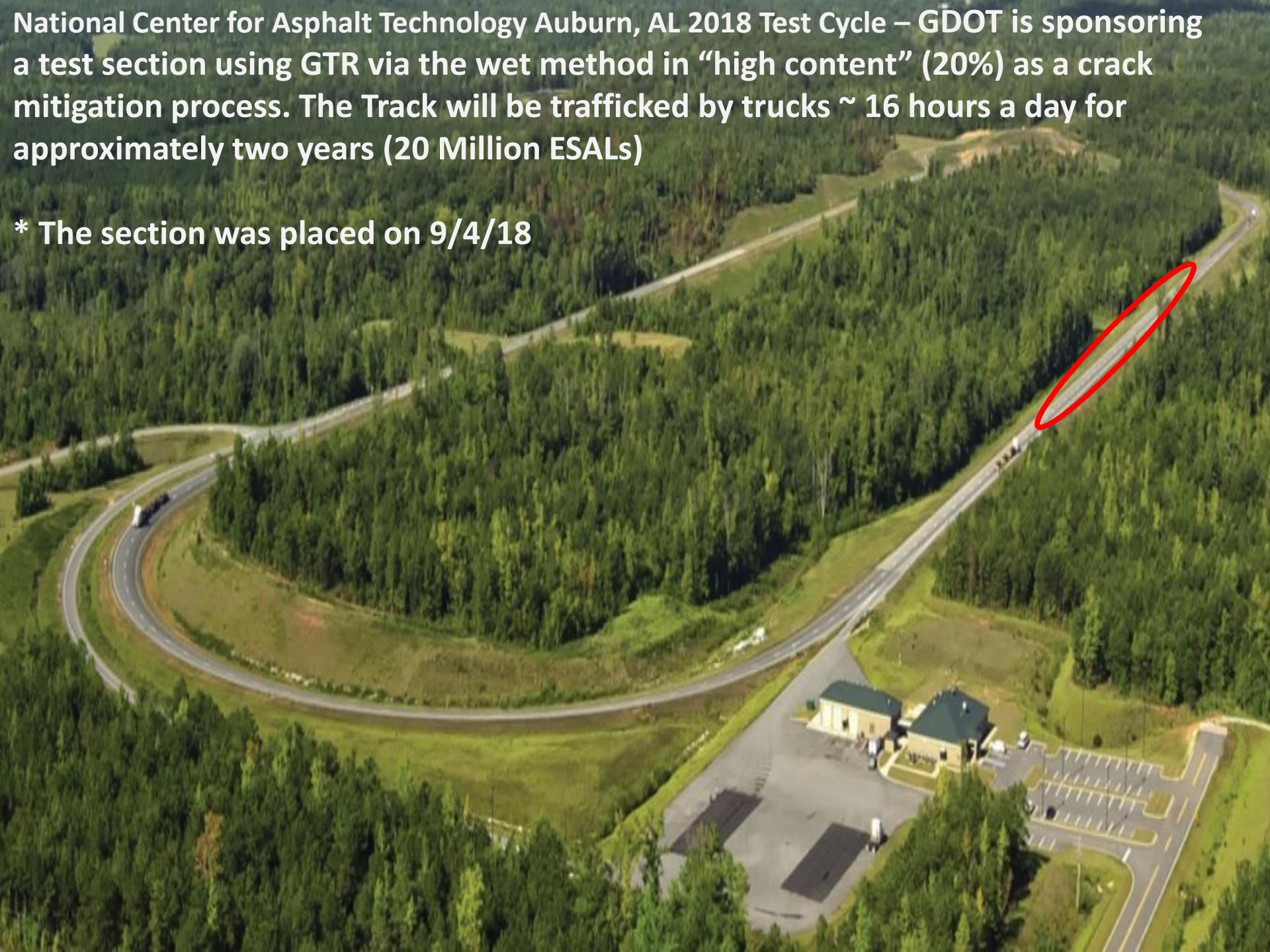
**I-75 – Valdosta, Georgia**

**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**

# Project Requirements

**Georgia Department of Transportation**

**State of Georgia**

**Special Provision**

**PROJECT NO.: M004921, Harris, Troup**

**P.I. NO.: M004921**

**Section 102.07 – Rejection of Proposals**

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*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.

# Project Assistance

## SPECIAL NOTICE TO CONTRACTORS

### 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](mailto:DCarlson@libertytire.com)



# Questions and comments?

