Developing Affordable GTR Asphalt Mixes for Local Roadways

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- Ms. Vicky Fout for her time and assistance.
Ground tire rubber (GTR) has been incorporated in asphalt mixtures to:
- Enhance the pavement performance
- Reduce environmental impact of pavements

GTR Mixtures Produced Using The Wet Process
Background

- ODOT has Supplement Specification 887 specifications for GTR asphalt binders and mixtures.

- Although the use of GTR may be beneficial for pavement quality and the environment, the GTR asphalt mixtures were not extensively used in Ohio.

- GTR has been used on approximately 33 local roads and 3 state highways since 2005.
Objectives

- Evaluate the long-term field performance of GTR
- Compare the life-cycle cost of GTR to traditional asphalt mixtures.
- Examine recent GTR technologies and assess their potential in reducing the initial cost of mixtures.
- Develop draft GTR mix design specifications to be used for local roads.
- Provide recommendations regarding QC/QA criteria for testing and acceptance of GTR mixtures.
Collect Information & Analyze Data

- All available information for GTR projects constructed in Ohio were collected. The collected information included:
  - Pavement information (e.g. layers thickness & traffic)
  - GTR asphalt mixtures information & properties
  - Problems encountered during construction
  - Pavement condition data
  - Dates and costs of maintenance/repair activities

- The collected data were analyzed.
Previous GTR Sections: Findings

- All GTR mixtures previously used in Ohio were produced using GTR binder from Seneca.
- After 10 years of service, GTR modified pavement sections had good performance.
- The use of GTR binder in place of a polymer modified PG 76-22M binder resulted in increasing the mixtures price by 10-15%:
  - Additional cost encountered by asphalt contractor when using a binder purchased from an asphalt supplier
  - Using GTR binders had resulted in increasing the required asphalt binder content by 0.2-0.5%. 
A multi-stage procedure was pursued to select the GTR technologies that can reduce the cost and yet can be used to produce a PG 70-22 binder with similar performance to that of a polymer modified binder.

- Identify new GTR technologies
- Compare Prices of GTR technologies
- Evaluate Selected GTR Binders
- Evaluate Selected GTR Mixtures
- Select Cheapest two GTR binders meeting PG-70-22
- Select Cheapest GTR binder meeting PG-70-22
## Price Comparison (Per Ton)

<table>
<thead>
<tr>
<th>Asphalt Product</th>
<th>PG 70-22</th>
<th>PG 76-22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seneca Petroleum-GTR asphalt</td>
<td>$660</td>
<td>$660</td>
</tr>
<tr>
<td>Wright-GTR asphalt</td>
<td>$675.00</td>
<td>$675.00</td>
</tr>
<tr>
<td>Quantum Polymer -GTR</td>
<td>$628.20</td>
<td>$642.70</td>
</tr>
<tr>
<td>Lehigh -GTR</td>
<td>$582.05</td>
<td>$582.05</td>
</tr>
<tr>
<td>Liberty –GTR</td>
<td>$561.6</td>
<td>$561.6</td>
</tr>
<tr>
<td>ODOT Price Index</td>
<td>$665.00</td>
<td>$695.80</td>
</tr>
<tr>
<td>SBS-Polymer modified Binder (Estimated Contactor cost)</td>
<td>$629.70</td>
<td>$652.00</td>
</tr>
</tbody>
</table>

Price were estimated based on ODOT asphalt binder price index for Oct. 2014
Cigar Tube Test Results

![Graph showing softening point results for GTR Liberty, GTR Lehigh, and GTR Lehigh+Rheopave with data points for TOP and BOTTOM.](image-url)
Mixture included:
- 47% limestone #8
- 16% natural sand
- 17% limestone sand
- 20% RAP
# Mixtures Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>70-22M</th>
<th>GTR Liberty*</th>
<th>GTR Lehigh*</th>
<th>GTR Lehigh+ Rheopave*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design air Void (%)</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Total Asphalt Binder Content (%)</td>
<td>6.1</td>
<td>6.3</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Virgin Asphalt Binder Content (%)</td>
<td>5.1</td>
<td>5.3</td>
<td>5.2</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*PG 64-22 +10%Liberty GTR  
PG 64-22 +10%Lehigh GTR  
PG 64-22 +7%Lehigh GTR+ 0.5%Rheopave
Lab Mixtures Testing

Conduct Laboratory Testing

- Low Temp Cracking: ACCD
- Fatigue Cracking: IDT
- Durability: AASHTO T283
- Rutting: APA
Low Temp. Cracking: ACCD Results

<table>
<thead>
<tr>
<th></th>
<th>70-22M</th>
<th>GTR Liberty</th>
<th>GTR Lehigh</th>
<th>GTR Lehigh+Rheopave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracking Temp.</td>
<td>-10</td>
<td>-15</td>
<td>-20</td>
<td>-25</td>
</tr>
<tr>
<td>STA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Create for Good.
Fatigue Cracking: IDT Results

![Bar chart showing ITS (psi) for various materials in dry and wet conditions.](chart.png)
Durability: AASHTO-T283 Results

- PG 70-22M
- GTR Liberty
- GTR Lehigh
- GTR Lehigh+Rheopave
Rutting: APA Results

- 70-22M
- GTR Liberty
- GTR Lehigh
- GTR Lehigh+Rheopave

Rut Depth (mm)
Lab Study Findings

- The GTR binders prepared using 10% Liberty GTR, 10% Lehigh GTR, or 7% Lehigh GTR and 0.5% Rheopave were the least expensive.
- The binders prepared using Liberty GTR, and Lehigh GTR had a continuous high PG grade higher than 76 °C and a low temperature PG grade lower than -22 °C.
- Mixtures prepared with Lehigh and Liberty GTR modified binders had better resistance to low temperature cracking than those prepared using PG 70-22 polymer modified binder.
Lab Study Findings

- In terms of rutting, all GTR mixes had lower rutting in the APA test and are expected to have better rutting performance than PG 70-22 polymer mixes.

- GTR mixes had slightly higher indirect tensile strength values than those prepared using PG 70-22M polymer modified binder.

- The results of the modified Lottman test (AASHTO T283) indicate that GTR modified mixes had similar moisture damage resistance to those prepared using polymer modified binder meeting PG 70-22M.
Field Evaluation of GTR Mixes

Four test sections with the following binders in the surface course mixture were constructed on Kenny Road in the City of Columbus:

- Section 1: SBS polymer to meet requirements for a PG 70-22M binder.
- Section 4: GTR modified binder - Liberty GTR (LI)
- Section 2: GTR modified binder - MicroDyne™-400 (LE)
- Section 3: GTR modified binder - MicroDyne™-400 GTR and Rheopave (LE-LH)

Construction started on 08/25/2016 and was completed 08/30/2016. One day was allocated for each GTR section.
Sections Location

Test Sections
Construction of Sections
Relative Compaction

Control (NB)  Control (SB)  LE-RH (NB)  LE-RH (SB)  LE (NB)  LE (SB)  LI (NB)  LI (SB)

Relative Compaction (%)
Binder & Core Sampling Testing

- Three quart samples of the GTR modified asphalt were obtained from the production line at the asphalt plant
  - DSR: high temperature grade
  - BBR&ABCD: Low temperature grade

- Twelve 6-inch cores were obtained from each test
Core Samples Testing

- Low Temp Cracking (ACCD)
- Fatigue Cracking (SCB)
- Durability (AASHTO T283)
DSR Testing Results

Testing Temperature: 70 °C

<table>
<thead>
<tr>
<th>Material</th>
<th>G*/sinδ (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-22M</td>
<td>1.3</td>
</tr>
<tr>
<td>GTR LIB</td>
<td>2.1</td>
</tr>
<tr>
<td>GTR LEH</td>
<td>1.6</td>
</tr>
<tr>
<td>GTR LEH-RH</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Specification: \( G*/\sin\delta \geq 1.0 \) kPa
BBR Testing Results

Low Temperature Grade (°C)

-30 -25 -20 -15 -10 -5 0 70-22M GTR LIB GTR LEH GTR LEH+RH

[Bar chart showing comparison of BBR and ABCD grades for 70-22M, GTR LIB, GTR LEH, and GTR LEH+RH]
ACCD Test Results

Cracking Temperature, °C

<table>
<thead>
<tr>
<th>Material</th>
<th>Cracking Temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-22M</td>
<td>-35</td>
</tr>
<tr>
<td>GTR LIB</td>
<td>-35</td>
</tr>
<tr>
<td>GTR LEH</td>
<td>-35</td>
</tr>
<tr>
<td>GTR LEH+RH</td>
<td>-35</td>
</tr>
</tbody>
</table>
SCB Test Results

Fracture Energy (J/m²)

- 70-22M
- GTR LIB
- GTR LEH
- GTR LEH+RH

[Bar chart showing fracture energy for different conditions]
Two Month Field Evaluations

Control

LEH

LEH-RH

LIB
Field Study Preliminary Findings

- All GTR mixtures were produced and compacted in the field without any problems.
- Binders obtained from the production line at the asphalt indicated that all GTR binders met PG70-22 specifications.
- The results of the laboratory tests showed that cores obtained from GTR sections had similar resistance to low-temperature and fatigue cracking as well as to moisture-induced damage as those obtained from the polymer modified PG 70-22M binder.
Thank you!!