Evolution of GTR Use in Louisiana

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Background

Approach
- Phase I
  - Evaluation: Field Performance
- Phase II
  - Evaluation: APT
- Phase III
  - Field

Ambient/Cryogenic

Summary

Sustainable Development

- “Meets the needs of the present without compromising the ability of future generations to meet their own needs”
  - World Commission on Environment and Development, 1987
- “Do unto future generations as you would have them do onto you”
  - Golden Rule

- Economic Sustainability
  - Balanced cost-revenue relationship
- Environmental Sustainability
  - Friendly to the ecosystems
  - Minimize use of natural resources
  - Reduce energy consumption
  - Reduce greenhouse gas emissions
- Social Sustainability: Material Performance
  - Better or same performance
  - Meet society’s needs
Background -- Waste Tires

- 1991 – Intermodal Surface Transportation Efficiency Act (ISTEA)
  - specified asphalt pavement project funded by federal agencies must use certain percentages of scrap tires
    - 5% in 1994
    - 20% by 1997
- Mandate was later suspended from the ISTEA legislation,
  - encouraged the research and application of CRM asphalt in HMA pavement.

Phase I Evaluation – 1994

LTRC Project Number 95-5B
Final Report: FHWA/LA.04/393

- Crumb-rubber modified (CRM) asphalt pavements in Louisiana
  - Evaluate field performance
- LADOTD sponsored research project
  - evaluate different procedures of CRM applications
  - monitor long-term pavement performance
    - Five different CRM applications
  - compare to companion control sections
    - conventional asphalt mixtures

Phase I: CRM Technology/Product

Wet Process
- Arizona / International Surfacing Inc. (ISI)
  - 16-mesh CRM
- Rouse
  - 80 mesh
- Neste Wright

Dry Process
- PlusRide™
- generic crumb rubber
  - 16-mesh
- Rouse
  - 80 mesh
Phase I Evaluation

- Processes of applying crumb-rubber in asphalt mixtures
  - Wet Process
    - Asphalt binder is pre-blended with the rubber
      - at high temperature
      - 177 – 210°C
    - specific blending conditions
    - Arizona (ISI), McDonald, Ecoflex, and Rouse continuous blending
  - Dry Process
    - added to aggregate prior to asphalt binder incorporated into the mixture
    - PlusRide™, chunk rubber, and generic dry

Phase I: Field Projects

- Five Field Projects
- Eight test section
- Six CRM Products
  - Arizona wet process incorporated into a gap-graded mixture; (US 61, LA 15)
  - Arizona wet process incorporated into a stress absorbing membrane interlayer (SAMI); (US 61)
  - Arizona wet process incorporated into an open-graded friction course (OGFC); (US 61)
  - PlusRide™ dry process utilizing a gap-graded aggregate structure; (LA 1040)
  - Rouse powdered rubber wet process incorporated into a typical dense-graded mixture; (LA 15)
  - A terminal blended material formulated by Neste Wright in a dense-graded mixture; (US 84)
  - Rouse dry-powdered rubber process blended into a dense-graded aggregate structure; (US 167)
  - Generic dry process incorporated into a gap-graded mixture. (US 167)

Phase I Evaluation

- Ten years field pavement performance
  - Conventional & CRM Sections
  - roadway core
    - density and mechanical test
  - International Roughness Index (IRI), Rutting
  - fatigue cracking.
Phase I -- LA 15: Rouse and Arizona

![Graph showing data over years for different categories.](image)
Phase II Evaluation

**Accelerated Pavement Testing (APT)**

- Build test sections using conventional construction equipment
- Compress 20 years of loading into 9-12 months

Weight = 110 K (55 ton)

Speed = 11 mph

Phase II Evaluation -- APT Test Lanes

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Lane 1</th>
<th>Lane 2</th>
<th>Lane 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.1 mm (1.5 inch)</td>
<td>WC CRM-HMA</td>
<td>CONV WC</td>
<td>CONV WC</td>
</tr>
<tr>
<td>50.8 mm (2.0 inch)</td>
<td>CONV BC</td>
<td>CONV BC</td>
<td>CONV BC</td>
</tr>
<tr>
<td>88.9 mm (3.5 inch)</td>
<td>CONV Base</td>
<td>Base CRM-HMA</td>
<td>CONV Base</td>
</tr>
<tr>
<td>215.9 mm (8&quot;)</td>
<td>Crushed Stone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>254 mm (10&quot;)</td>
<td>Cement Treated Embankment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phase II Evaluation -- Summary

- Wearing Course: CRM vs Conv
  - showed similar laboratory properties
  - Similar rutting

- Base Course: CRM vs Conv
  - improved lab properties
  - Lower rutting

- Final Report (FHWA/LA.03/374)
  - Comparative Performance of Rubber Modified Hot Mix Asphalt Under ALF Loading
    - [www.LTRC.LSU.EDU](http://www.LTRC.LSU.EDU)

Phase I & II Evaluation: Outcome

- September 2007
  - Developed binder performance graded (PG) specification
    - Ground tire rubber
    - PG 82-22rm

- December 2007
  - Rubber Modified Binder Specification Meeting
  - Material supplier, Contractor, State, Academic
    - Challenges & opportunities

- April 2008
  - Binder PG 82-22rm was adopted in LDOTD specifications
  - 30 mesh crumb
    - 90-100 percent passing No. 30 sieve

Indirect Tensile Strength, 25°C

- [Chart showing indirect tensile strength for PG 82-22rm and PG 76-22 CONV](chart.png)
Rutting: AASHTO T 324
Loaded Wheel Track Test, 50°C

<table>
<thead>
<tr>
<th>Rut Depth (mm)</th>
<th>PG 82-22rm</th>
<th>PG 76-22 CONV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification Limit</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Phase III

- LDOTD asphalt cement specification requires
  - elastomeric type of polymer modifier
    - Styrene Butadiene Styrene (SBS)
  - enhanced performance
    - rutting and fatigue cracking
- Shortage in SBS
  - 2008
    - reported by several polymer suppliers
- Potential to utilize crumb rubber from waste tires

Field Projects

<table>
<thead>
<tr>
<th>Date</th>
<th>Route</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/08</td>
<td>I-12</td>
<td>15K</td>
</tr>
<tr>
<td>02/09</td>
<td>I-10</td>
<td>60K</td>
</tr>
<tr>
<td>06/09</td>
<td>LA 983</td>
<td>7K</td>
</tr>
<tr>
<td>11/09</td>
<td>I-12</td>
<td>100K</td>
</tr>
<tr>
<td>03/10-6/11</td>
<td>I-55</td>
<td>200K</td>
</tr>
</tbody>
</table>
Monitor Performance
Update Specification
VFA
Incorporate performance tests
High Temp: LWT
Intermediate Temp: LA SCB
Three types of crumb rubber:
- Ambient, Cryogenic, and Ecorphalt rubber
- Each was blended with PG 67-22 asphalt binder at 170º and 190ºC

Binder experiment:
- Gel Permeation Chromatography (GPC)
- Thermogravimetric analysis (TGA)

Mixture experiment:
- High temperature properties
  - Hamburg Type Loaded Wheel Tracking test
  - AASHTO T 324
- Intermediate temperature properties
  - Semi-Circular Bending test
  - ASTM D8044

**Mixture Intermediate Temperature Cracking Performance**
**Semi-Circular Bend Test Results, 25ºC**
Findings
- Blending temperature had no impact on intermediate temperature cracking performance of asphalt mixture containing 10% Amb-R as measured by SCB Jc.
- An increase in blending temperature from 170°C to 190°C resulted in a reduction of SCB Jc for asphalt mixture containing 10% Cryo-R.
- An increase in blending temperature from 170°C to 190°C resulted in an improvement of SCB Jc for asphalt mixture containing E-Rubber.
- Neither CR type nor blending temperatures impacted mixtures' responses at high temperature as compared to the control mixture 76-CO as measured by LWT.
- Intermediate temperature cracking as measured by SCB Jc was similar between Ambient and Cryogenic when blended at 170°C.

LDOTD specifications (2016)
- **1002.02.2 Crumb Rubber**: Waste Tire Rubber must be pre-qualified by the Materials Laboratory. The maximum size of rubber particles shall be 30 mesh crumb (90-100 percent passing the No. 30 sieve).
- Maximum replacement of 10 percent by weight of asphalt material.
- No cryogenic crumb rubber is allowed.
- Performance Grade Specification PG-82-22m
- MSCR defined specs
  - Jnr (3.2kPa) 0.5-
  - % Recovery (3.2kPa) meets curve defined in AASHTO M332.
**LDOTD specifications Changes**

- **1002.02.2 Crumb Rubber (07/18):** Waste Tire Rubber must be pre-qualified by the Materials Laboratory. The maximum size of rubber particles shall be 30 mesh crumb (90-100 percent passing the No. 30 sieve) with a maximum replacement of 10 percent by weight of asphalt material.
  
  - NOTE: No reference to Cryogenic crumb rubber not being allowed.
  
  - SPEC change allows the use of either Cryogenic or ambient crumb rubber

- **Cryogenic and Ambient CR blended at 170°C**

- **PG 82-22RM removed from specification**
  
  - PG 76-22RM is utilized

- **VFA increased by 3% when PG 76-22RM is used.**

**Summary**

- **Use of crumb rubber** is a promising technology
  - Sustainable choice
  - Better or similar performance
  - Satisfying current market needs with respect to supporting the recycling of scrap tires

- **CR generally improved cracking performance**

**Thank You**

_P.S._

*Any and all questions referred to Drs. Mohammad and Cooper, III*