Louisiana Case Study: Implementation of CRM Binder in PG specs

Sustainable Materials for Pavement Infrastructure: Use of Waste Tires in Asphalt Mixtures
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My Story

• Background
• Approach
  – Phase I
    • Evaluation: Field Performance
  – Phase II
    • Evaluation: APT
• Summary
Sustainability
Materials/Technology

Recycled Materials
Waste Tires
Waste Tires

• 1991 – Intermodal Surface Transportation Efficiency Act (ISTEA)
  – specified that all 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

- Crumb-rubber modified 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 the aggregate before the asphalt binder is charged 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

- Ten years field pavement performance
  - Conventional & CRM Sections
  - roadway core density,
  - International Roughness Index (IRI),
  - Rutting
  - fatigue cracking.
Phase I
US 61: wet Arizona Process

Graph showing the IRI (International Roughness Index) in miles from 1994 to 2012 for different materials:
- CRM / SMA
- SBS / SMA
- SBS / Type 8F

The graph indicates a trend where the IRI values for CRM / SMA and SBS / SMA generally increase, while those for SBS / Type 8F show a decrease initially, followed by an increase.
Phase I
US 61: Wet Process

Random Cracking, L.F.

Year


CRM / SMA
SBS / SMA
SBS / Type 8F

IT Strain
0.50
0.76
1.61
Phase I-US 84: Terminal Blended

Neste Wright

[Graph showing IRI (International Roughness Index) over years for CRM / Type 8F and SBS / Type 8F.]
Phase I: US 84
Terminal Blended Neste Wright

- CRM / Type 8F
- SBS / Type 8F

Random Cracking, L.F.

Year

Phase I - US 84: Terminal Blended Neste Wright
Phase I US 167: Dry Process Rouse and Generic
Phase I US 167: Dry Process Rouse and Generic
Phase I US 167: Dry Process
Rouse and Generic
Phase I LA 15: 40 Mesh Rouse Dense and Arizona SMA
Phase I -- LA 15: Rouse and Arizona
Phase I -- LA 15: Rouse and Arizona
Phase II Evaluation
Accelerated Pavement Testing (APT)

- Build test sections using conventional construction equipment
- Compress 20 years of loading into 9-12 months
<table>
<thead>
<tr>
<th>Thickness</th>
<th>Lane 1</th>
<th>Lane 2</th>
<th>Lane 3</th>
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<tbody>
<tr>
<td>WC-38.1 mm</td>
<td>CRM-HMA</td>
<td>SBS modified ~PG76-22</td>
<td>SBS modified ~PG76-22</td>
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<tr>
<td>(1.5 inch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC-50.8 mm</td>
<td>SBS modified ~PG76-22 w/20% RAP</td>
<td>SBS modified ~PG76-22 w/20% RAP</td>
<td>SBS modified ~PG76-22 w/20% RAP</td>
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<tr>
<td>(2.0 inch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base-88.9 mm</td>
<td>~PG 64-22 Base</td>
<td>CRM-HMA</td>
<td>~PG64-22 Base</td>
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<tr>
<td>(3.5 inch)</td>
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<td></td>
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<tr>
<td>215.9 mm (8”)</td>
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<td>Crushed Stone</td>
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<tr>
<td>254 mm (10”)</td>
<td></td>
<td>Cement Treated Embankment</td>
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LTRC Report 374 –
Accelerated Loading of Modified AC
Phase II Evaluation Summary

- **Wearing Course:** CRM vs SBS
  - showed similar laboratory properties
  - Similar rutting in lab and on ALF

- **Base Course:** CRM vs PG64-22
  - improved lab properties
  - Lower rutting in lab and on ALF

- **Final Report**
- **Comparative Performance of Rubber Modified Hot Mix Asphalt Under ALF Loading**
  - [www.LTRC.LSU.Edu](http://www.LTRC.LSU.Edu), Report 374
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
Indirect Tensile Strength, 25°C

- **Unaged**
- **Aged**

**PG 82-22rm**

**PG 76-22 CONV**
Indirect Tensile Strain, 25°C
Rutting:
Loaded Wheel Track Test, 50°C

- PG 82-22rm
- PG 76-22 CONV

Rut Depth (mm)

Specification Limit
Challenges

• General Supplier modification preference is SBS
  – Material specifications
  – Production and supplier issues
    • Proliferation of material types increases storage requirements
    • Storage stability,
    • Temperatures and time required to add rubber at the refinery or terminal.
  – Construction
    • Ability for the contractor to compact the rubber modified mixture at normal compaction temperatures
  – Research, technical assistance, and training
    • Focused on examining materials and methods that will improve performance of waste tire rubber.
Phase III
PG82-22rm field projects

<table>
<thead>
<tr>
<th>Date</th>
<th>Route</th>
<th>Tonnage</th>
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<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>
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<tr>
<td>03/10</td>
<td>I-55</td>
<td>200K</td>
</tr>
<tr>
<td>-6/11</td>
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<td></td>
</tr>
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</table>
Implementation Wet Process
PG 82-22rn
Blended at Contractors Tank
I-10 Gramercy to Sorrento
LA’s experience with CRM modified OGFC and SMA

- Superior Rut resistance
- Superior Surface Texture
- Safest Surface for wet weather
- Superior Resistance to reflective cracking of transverse joints over composite pavements
Surface Texture
LTRC report 485
MSCR Results @ 64ºC

Graph showing % Recovery @ 3.2 kPa versus J_{nr} @ 3.2 kPa for different grades of PG and PG 82 CRM.
MSCR Results @ 70ºC

Graph showing the relationship between % Recovery @ 3.2 kPa and Jnr @ 3.2 kPa for various materials such as PG 76 - I, PG 76 - II, PG 76 - III, PG 76 - IV, PG 76 - V, PG 76 - VI, PG 70 - I, PG 70 - II, PG 70 - III, PG 70 - IV, PG 70 - V, PG 70 - VI, PG 82 CRM - I, PG 82 CRM - II, PG 82 CRM - III, and PG 82 CRM - IV.
E* Comparisons:

![Graph showing E*(I55_CRM)/E*(US61_76CO) ratios across different temperatures and frequencies.](image)

- **E*(I55_CRM)/E*(US61_76CO)**
  - Frequency (Hz)
  - E* Ratios
  - Temperatures: -10C, 4.4C, 25C for the first graph.
  - Temperatures: 37.8C, 54.4C for the second graph.

The graphs illustrate the comparison of E* ratios for two different materials at various temperatures and frequencies.
LOUISIANA SUPERPAVE BINDER SPECs

PG 82-22RM  PG 76-22M  PG 70-22M  PG 64-22*
High Volume  High Volume  Low Volume  Base mix

ORIGINAL BINDER
FLASH POINT, 230 C Max,
ROTATIONAL VISCOSITY, 135 C, 3 Pa * s, Max,
DSR, G*/Sin Delta @ Specified High Temp., 1KPa, Min.
(1.3 KPa for PG64 -22)

RTFO aged; (1% Max. Loss in RTFO)
DSR, G*/Sin Delta @ Specified High Temp., 2.2 KPa, Min.

PAV aged, (uniform specs for all - 22 grades)
DSR @ 25 C, G* x Sin Delta, = 5000 KPa Max; (4000 max for 64-22)
BBR, @-12 C, 300 MPa max stiffness and minimum slope of 0.300.

*Note: PG 58-28 required when 21-30% RAP is used in base course mixes.
LOUISIANA SUPERPAVE BINDER SPECS, Modified Requirements

Original Binder:

Separation Test, 2 C max. difference on ring and ball

PG76-22m; Force Ratio @ 4 C, 30 cm: $F_2 / F_1 = 0.3$ Min.
---Separation Test 2C max

PG 70-22m; Force Ductility @ 4 C, 30 cm. = 0.5 Lb. Min
-- Separation Test 2C max

RTFO material:

Elastic Recovery, Min. Recovery at 25 C,
PG 82RM and PG76m - 60% MinPG70m - 40% Min
Summary

- **Crumb Rubber, PG82-22rm:**
  - Provides a sustainable choice supporting the recycling of scrap tires
  - Provides similar or better lab mix performance to PG76-22 standard
  - In SMA and OGFC exhibits excellent performance in reducing traverse crack propagation in composite pavements
  - Improves actual pavement performance as measured by PMS.
I told you not to use bleach

Shut up!