Louisiana Case Study: Implementation of CRM Binder in PG specification

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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
Background -- 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 Project

- 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,
- International Roughness Index (IRI),
- Rutting
- Fatigue cracking.
Phase I -- US 61: wet Arizona Process
Phase I -- US 61: Wet Arizona Process

![Graph showing random cracking over years for CRM/SMA, SBS/SMA, and SBS/Type 8F with IT strain data points.]
Phase I -- US 84: Terminal Blended

Neste Wright

[Graph showing data over years]
Phase I -- US 84: Terminal Blended

Neste Wright
Phase I -- US 84: Terminal Blended

Neste Wright

![Graph showing the average rut (inches) from 1996 to 2008. The graph compares two types: CRM / Type 8F and SBS / Type 8F. The SBS / Type 8F shows a steady increase, while the CRM / Type 8F remains relatively constant.](image-url)
Phase I -- US 167: Dry Process
Rouse and Generic

![Graph showing the performance of different materials over time with IRI values in miles.](image-url)
Phase I -- US 167: Dry Process
Rouse and Generic
Phase I -- US 167: Dry Process
Rouse and Generic
Phase I -- LA 15: Dense 40 Mesh Rouse and SMA Arizona

![Graph showing IRI values for SBS / Type 8F, Rouse Dense-Graded, and CRM Gap-Graded over years from 1996 to 2006.]
Phase I -- LA 15: Rouse and Arizona
Phase I -- LA 15: Rouse and Arizona

The graph shows the average rut (inches) over the years 1996 to 2006 for different materials:
- SBS / Type 8F
- Rouse Dense-Graded
- CRM Gap-Graded

The data indicates a slight increase in average rut over the years for all materials.
Phase II Evaluation
Accelerated Pavement Testing (APT)

- Build test sections using conventional construction equipment
- Compress 20 years of loading into 9-12 months
## 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>WC-38.1 mm</td>
<td>CRM-HMA</td>
<td>SBS modified ~PG76-22</td>
<td>SBS modified ~PG76-22</td>
</tr>
<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</td>
<td>SBS modified ~PG76-22</td>
<td>SBS modified ~PG76-22</td>
</tr>
<tr>
<td>(2.0 inch)</td>
<td>w/20% RAP</td>
<td>w/20% RAP</td>
<td>w/20% RAP</td>
</tr>
<tr>
<td>Base-88.9 mm</td>
<td>~PG 64-22 Base</td>
<td>CRM-HMA</td>
<td>~PG64-22 Base</td>
</tr>
<tr>
<td>(3.5 inch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>215.9 mm (8”)</td>
<td></td>
<td>Crushed Stone</td>
<td></td>
</tr>
<tr>
<td>254 mm (10”)</td>
<td></td>
<td>Cement Treated Embankment</td>
<td></td>
</tr>
</tbody>
</table>
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, 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

PG 82-22rm

PG 76-22 CONV

Unaged
Aged

ITS (psi)
Indirect Tensile Strain, 25°C

- CRM 76 CO
  - Unaged
  - Aged

IT Strain (percent)

- CRM
- 76 CO
Rutting:
Loaded Wheel Track Test, 50°C

![Graph showing rut depth comparison between PG 82-22rm and PG 76-22 CONV](graph.png)
## Phase III

### 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>
Implementation Wet Process
PG 82-22m
Blended at Contractors Tank
I-10 Gramercy to Sorrento
Plant blending facility
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

Mean Profile Depth by Surface Type

- Thin Lift - OGFC
- SMA and Thin Lift - Coarse Gradation
- SUPERPAVE Dense Mix

<table>
<thead>
<tr>
<th>Surface Type/Route</th>
<th>Mean Profile Depth (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 61 NB</td>
<td>30</td>
</tr>
<tr>
<td>US 61 SB</td>
<td>25</td>
</tr>
<tr>
<td>US 61 NB</td>
<td>55</td>
</tr>
<tr>
<td>US 61 SB</td>
<td>50</td>
</tr>
<tr>
<td>I-12 EB</td>
<td>45</td>
</tr>
<tr>
<td>I-12 WB</td>
<td>40</td>
</tr>
</tbody>
</table>
MSCR Results @ 64ºC
LOUISIANA SUPERPAVE BINDER SPECS

<table>
<thead>
<tr>
<th>PG 82-22RM</th>
<th>PG 76-22M</th>
<th>PG 70-22M</th>
<th>PG 64-22*</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Volume</td>
<td>High Volume</td>
<td>Low Volume</td>
<td>Base mix</td>
</tr>
</tbody>
</table>

ORIGINAL BINDER

FLASH POINT, 230 C Max.
ROTATIONAL VISCOSITY, 135 C, 3 Pa * S, Max.
DSR, G*/Sin Delta @ Specified High Temp., 1 KPa, 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:

*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% Min*  
PG70m - 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.
THANK YOU