Evolution of GTR Use in Louisiana

Samuel Cooper, Jr., Ph.D., P.E.
Louay Mohammad, Ph.D., P.E. (WY)
Samuel Cooper, III, Ph.D., P.E.

Louisiana Transportation Research Center

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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 onto future generations as you would have them do onto you"*
  - Golden Rule

- ***Economical*** 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: Materials 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

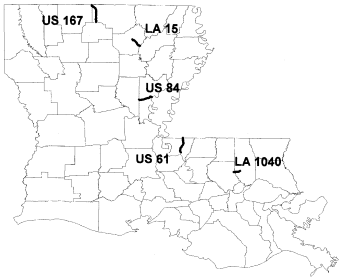
Dry Process

- 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 – 210C
      - 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

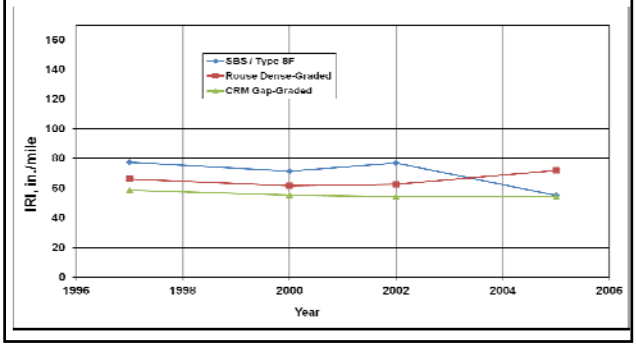


- Five Field Projects
- Eight test section
- Six CRM Products
  - Arizona wet process incorporated into a gap-graded mixture; (US 61, LA 15)
  - Arizona wet process incorporated into a stress absorbing membrane interlayer (SAMI); (US 61)
  - Arizona wet process incorporated into an open-graded friction 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)

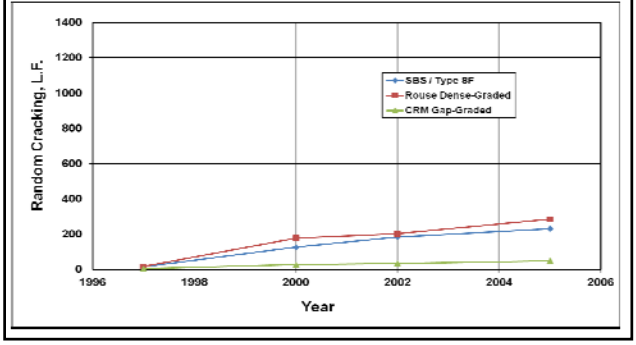
Phase I Evaluation

- Ten years field pavement performance
  - Conventional & CRM Sections
  - roadway core
    - density and mechanical test
  - International Roughness Index (IRI),
  - Rutting
  - fatigue cracking.

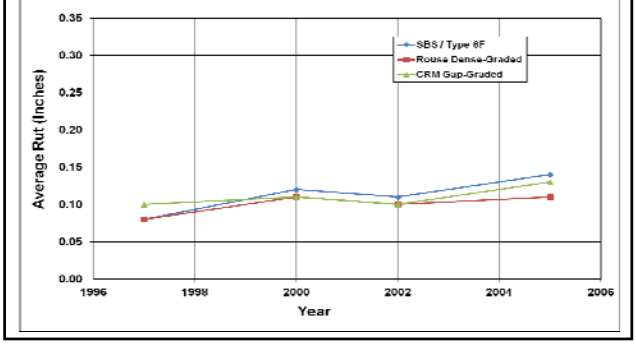
Phase I -- LA 15: Rouse and Arizona



Phase I -- LA 15: Rouse and Arizona



Phase I -- LA 15: Rouse and Arizona

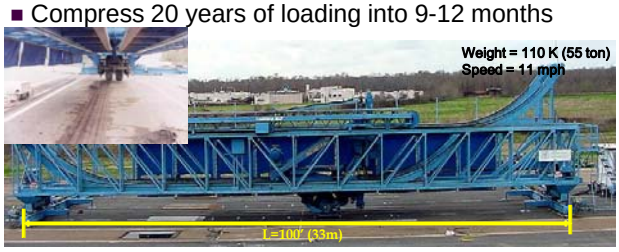


Evaluation of Crumb Rubber Modified Asphalt
LTRC No. 95-5B

Project No.	Description	Year 2005 Begin C.S.L.M.	END C.S.L.M.	AVG IRI	AVG TRNCRK	AVG RNDM	AVG ALGCRK	AVG RUT
019-05-0024 US 61	1" OGFC w/SAMI	8.350	9.350	101	346	574	461	0.21
	CRM Gap-Graded	9.350	13.850	120	300	307	232	0.27
	Poly. Gap-Graded	13.850	14.850	117	193	635	363	0.23
	Conventional	*14.850*	*15.850*	92	*96*	1641	*405*	0.29
832-23-0009 (Lead) LA 1040	Plusride (832-23-0009) Gap-Graded	0.000	1.360	150	328	393	95	0.18
	Plusride (853-10-0012) Gap-Graded	0.000	3.057	128	240	282	74	0.20
	Conventional	3.057	4.800	110	180	596	296	0.24
022-06-0041 US 84	*CRM Dense-Graded*	*3.669*	*5.658*	59	*10*	1771	*244*	0.20
	Conventional	5.658	7.784	58	81	228	1219	0.35
026-10-0018 LA 15	Conventional	0.000	1.726	55	207	231	36	0.14
	Rouse Dense-Graded	1.726	3.726	72	203	284	399	0.11
	CRM Gap-Graded	3.726	5.726	54	46	48	40	**0.13**
023-11-0028 US 167	*1% Rouse Dense-Graded*	*0.709*	*2.709*	70	130	134	*490*	0.09
	2% Rouse Gap-Graded	2.709	4.709	101	229	247	648	0.19
	Conventional	4.709	7.421	113	202	206	564	0.22

Phase II Evaluation
Accelerated Pavement Testing (APT)

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

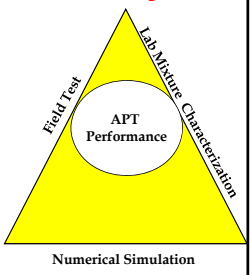


Phase II Evaluation -- APT Test Lanes

Thickness	Lane 1	Lane 2	Lane 3
38.1 mm (1.5 inch)	WC CRM-HMA	CONV WC	CONV WC
50.8 mm (2.0 inch)	CONV BC	CONV BC	CONV BC
88.9 mm (3.5 inch)	CONV Base	Base CRM-HMA	CONV Base
215.9 mm (8")	Crushed Stone		
254 mm (10")	Cement Treated Embankment		

Phase II Evaluation -- Summary

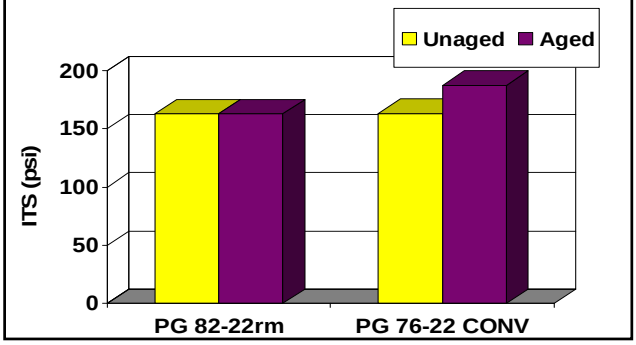
- Wearing Course: CRM vs Conv
  - showed similar laboratory properties
  - Similar rutting
- Base Course: CRM vs Conv
  - improved lab properties
  - Lower rutting
- Final Report (FHWA/LA.03/374)
- Comparative Performance of Rubber Modified Hot Mix Asphalt Under ALF Loading
  - (www.LTRC.LSU.EDU



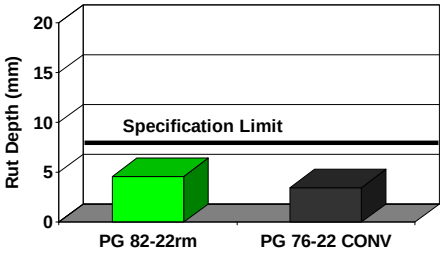
Phase I & II Evaluation: Outcome

- **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



Rutting: AASHTO T 324 Loaded Wheel Track Test, 50°C

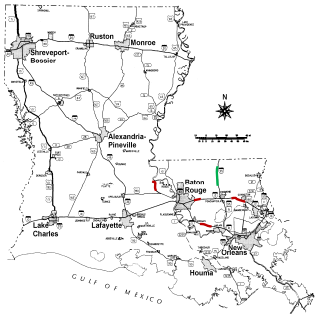


Phase III

- 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*

Phase III

Field Projects

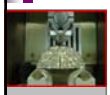


Date	Route	Tonnage
10/08	I-12	15K
02/09	I-10	60K
06/09	LA 983	7K
11/09	I-12	100K
03/10-6/11	I-55	200K

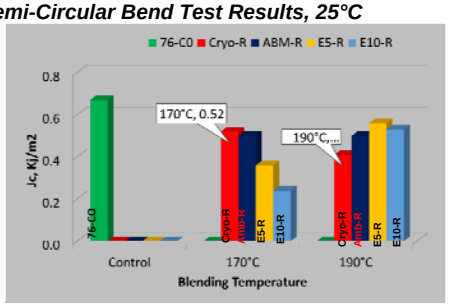

Monitor Performance
Update Specification
VFA
Incorporate performance tests
High Temp: LWT
Intermediate Temp: LA SCB
Implementation Wet Process
PG 82-22m
Blended at Contractors Tank
I-10 Gramercy to Sorrento

Ambient / Cryogenic

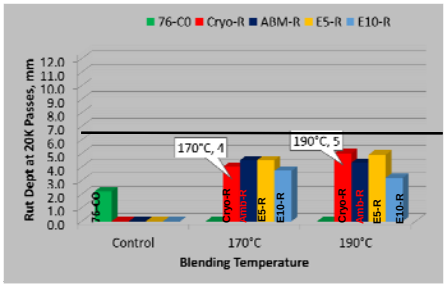
- Three types of crumb rubber
  - Ambient, Cryogenic, and Ecorphalt rubber
  - Each was blended with PG 67-22 asphalt binder at 170º and 190ºC
- Binder experiment
  - Gel Permeation Chromatography (GPC)
  - Thermogravimetric analysis (TGA)
- Mixture experiment
  - High temperature properties
    - Hamburg 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, 25°C



Mixture High Temperature Performance LWT, 50C



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 blending temperature from 170°C to 190°C resulted in a reduction of SCB Jc for asphalt mixture containing *10% Cryo-R* −
- An increase blending temperature from 170°C to 190°C resulted in a an improvement of SCB Jc for asphalt mixture containing *E-Rubber* +
  - *Increase in blending temperature enhanced dissolution E-Rubber in asphalt binder*
- 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-82-22rm
- 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