History of Asphalt Rubber in Arizona

George Way
Consulpav

2012 Arizona Pavements/Materials Conference

October 31, 2012
Tempe, Arizona
Asphalt Rubber

The Early Years, Trial and Error

SAM’s and SAMI’s

Hot Plant Mixes, Gap Graded and Open Graded

Benefits

The People and Organizations

The Future
Historical Overview of Crumb Rubber in Asphalt

1960s Charles McDonald
Experiments w/AR

1970s AR Field City of Phoenix
and ADOT Chip Seal Coat (SAM)

1978 Several AR patents

1985-88 AR Gap Graded & Open
Graded Mixes

1993 ISTE A controversy 1994
ASTM Specification 1995
Patents expire

1997 RPA Formed

2000-2009 Three International AR Conf.

Charlie (center) at First National A-R Conf.
1980

Others: Dr. J. Love FHWA, Dr. J. Epps Tex A&M, Dr. B. Galloway TTI, Gene Morris ATRC
History of Crumb Rubber-Asphalt

1920-1950’s Pre-Rubber Asphalt
1960’s Early Development
1970’s Chip Seal Coats
1980’s Gap Graded & Open Graded Mixes
1990’s Politics & Starting Over
2000’s Performance, Research, Environment, Costs
2010+ Market Changes, International
Asphalt-Rubber PG Binder Grading, WMA
1950’s Used asphalt to patch cracked roof of trailer when travelling with US Bureau of Public Roads (now FHWA).

• Mixed in ground tire rubber while heated to increase flexibility.

• Created pot-hole “band aid” for City of Phoenix 1960s
Charles McDonald
Inventor of Asphalt Rubber

McDonald Applying AR Band Aid Patch Circa 1966

Asphalt Rubber Band Aid Patch Circa 1966
Early Chip Seal Spreader Truck Technology Mid 1970s
Early Hot Mix Application Placed 1975 Through Mid 1980’s

Arizona AR SAM

Belgium AR Open Graded

South Africa AR SAM
Stress Absorbing Membrane Interlayer (SAMI)

Asphalt-Rubber Membrane & Aggregate Chips

Surface Course

Asphalt Overlay

SAMI

Crack Energy Dissipated by AR Membrane

Cracked Pavement
Asphalt-Rubber Binder Application
1980’s Marshall Mix Gradation for HMA And Gap Graded Asphalt Rubber Mixes

Marshall Mixes
5.1 % Asphalt Air Voids 5.9 %
16.5 % VMA

Asphalt Rubber Gap Graded Mix
7.3 % Asphalt Air Voids 5.2 %
20.2 % VMA
1980’s Open Graded Mix Gradations

Open Graded Mix
6.0 % Asphalt Air Voids 20.8 %
VMA 29.1 %

Asphalt Rubber Open Graded Mix
9.2 % Asphalt Rubber Air Voids 20.2 %
VMA 32.5 %
Film Thickness

Dense Graded
HMA
9 Micron

Gap Graded
Asphalt Rubber
18 Micron

Open Graded
Asphalt Rubber
36 Micron
Example Dense-Graded HMA vs. AR Open

Item 341 Dense-Graded Hot Mix Asphalt Type C (Coarse Surface)

Dense Graded

Item 342 Permeable Friction Course (PFC) PG 76 Mixtures

Open Graded w/Asphalt Rubber
Asphalt-Rubber Mixes

- AR-OGFC
- AR-AC
- HMA Base Mix
- 1 Inch AR-OGFC
“Asphalt-Rubber is a blend of asphalt cement, reclaimed tire rubber and certain additives, in which the rubber component is at least 15% by weight of the total blend and has reacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles.”
Asphalt-Rubber Binder with Rubber Particles

Asphalt Binder, Neat asphalt, Polymer Asphalt, Terminal Blend
Rubber Particle Interaction

Before

After
Effect Rubber Quantity, Rotational Viscosity

Viscosity, 177°C, 350°F, cp

Rubber Percent by Weight of Total Binder

Typical asphalt-rubber viscosity range
Resilience
Effect of Rubber Quantity

Percent Rubber by Weight of Total Binder
2000’s Performance, Research, Environment & Costs

Arizona DOT % Cracking vs. Years of age

- HMA Dense graded mixes
- AR mixes
Arizona Quiet Pavement Program

ADOT Adoption of Quiet Pavement Program to Reduce Noise From Concrete Pavement

- Adoption of QPP Due to Less Noise From Asphalt-Rubber
- Citizens Noted Less Noise From AR Open Graded Course
- AR Open Graded Course 25 mm Thick
- ADOT Conducted Numerous Research Studies on Noise Reduction Benefits of ARFC Starting in 1995
- ADOT Completed a Noise Study in January 2002 on a Concrete Test Section of SR 101 Overlaid With ARFC
- ADOT Started the QPPP in April 2003, in Accordance With An Agreement Between FHWA and ADOT
## Arizona Quiet Pavement Program

**ADOT US 60**

<table>
<thead>
<tr>
<th>Location</th>
<th>Concrete Before</th>
<th>Concrete After</th>
<th>ARFC Before</th>
<th>ARFC After</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder (15m)</td>
<td>79.8</td>
<td>72.6</td>
<td>79.8</td>
<td>72.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Soundwall (30m)</td>
<td>76.6</td>
<td>67.1</td>
<td>76.6</td>
<td>67.1</td>
<td>9.5</td>
</tr>
<tr>
<td>Residential (120m)</td>
<td>51.7</td>
<td>45.6</td>
<td>51.7</td>
<td>45.6</td>
<td>6.1</td>
</tr>
</tbody>
</table>
Asphalt-Rubber Noise Reduction – Noise Testing Equipment – On Board Sound Intensity (OBSI)
Asphalt Rubber Open Graded
Quietest Surface
Total Annual kg CO2 Eq. / km

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Transportation kg An. CO2 Eq. / km</th>
<th>Mixing kg An. CO2 Eq. / km</th>
<th>Production kg An. CO2 Eq. / km</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR 50mm, Base 150mm</td>
<td>2,386</td>
<td>5,381</td>
<td>2,718</td>
</tr>
<tr>
<td>UTW 50mm, HMA 50mm, Base 150mm</td>
<td>2,526</td>
<td>4,124</td>
<td>7,951</td>
</tr>
<tr>
<td>HMA 100mm, Base 150mm</td>
<td>3,722</td>
<td>11,210</td>
<td>4,517</td>
</tr>
</tbody>
</table>
Recycling of Asphalt-Rubber Mix 2007

ARFC Hot Plant
Recycled mix into
I-19 Frontage Road

ARFC Recycled in Place on I-19, note Joint cracks
Asphalt Rubber Benefits

- Less Reflective Cracking
- Less Maintenance/More Durable
- Less Raveling
- Good Rut Resistance
- Good Skid Resistance
- Smooth Ride
- Good in hot & cold climates
- Less Splash & Spray Better Drainage
- Less Noise
- Cost Effective
- Engineering Use for Old Tires

Sustainable Green Material
Charles H. McDonald
Bill Brake –
Sahuarao Asphalt & Petroleum
/Edgington Oil

Don Nielsen,
Chairman of the Board
Arizona Refining Company
/Union Oil Comp
Gene Morris –
ADOT Research Engineer

William “Bill” Price
ADOT State Engineer

Fred Glendenning, Director of
Public Works for the City of
Phoenix
Donna Carlson
RPA – Past Director

Mark Belshe
RPA – Present Director

Doug Carlson
RPA – Past Director
Supporters of Asphalt Rubber

Joe Cano – City of Phoenix

Anne Stonex – Industry

Doug Forstie – ADOT

And Many, Many More
Asphalt Rubber Companies, Rubber Suppliers and Organizations

Sahuarro Petroleum and Asphalt Co. – Bill Brake
Arizona Refining Company – Don Nielsen
BearCat – Ken Hill
Crafco – Bill Brake, Fred McWeeny, Ken Hill, Carl Jacobson, E.J. Johnson
International Surfacing Inc. – Carl Jacobson
International Surfacing Systems – Jeff Reed
Asphalt Rubber Companies, Rubber Suppliers and Organizations

Atlos Rubber – Bob Winters
Genstar – Fernly Smith
Baker Southwest – Tim Baker
PolyTeK Southwest/Neste – Mike Masson
Landstar Rubber Inc. – D. Elroy Fimrite
CRM – Barry Takalou
Asphalt Rubber Companies, Rubber Suppliers and Organizations

1985 - Present

Asphalt Rubber Producers Group – Russ Schnormier, Gary Cooper – Al France

Rubber Pavements Association – Donna Carlson – Doug Carlson - Mark Belshe
Other Supporting Agencies, Funding, Research, Projects

Arizona Department of Transportation
City of Phoenix
Federal Highways Administration
University of Arizona
Arizona State University
And many, many more
Future of Rubber in Asphalt
Rubberized Asphalt

- Asphalt-Rubber – 15 % or more recycled tire rubber in the asphalt
- Asphalt-Rubber Light – Less than 15% recycled tire rubber in the asphalt
- Rubberized Asphalt Binder - Combination of recycled tire rubber and polymer in the asphalt
- Rubberized Asphalt Activated - Combination of recycled tire rubber and charged particles in the asphalt
2010+ Market Changes
International
• Cost of Asphalt
• Cost of Polymer
• Availability of Polymer
• Tighter Highway Funding Budgets
• Pavement Preservation Needs
• Thinner Pavements and/or Surface Treatments
• Reasons to Consider Rubberized Asphalt
• with GTR

$ $ $ $ $ $ $ $ $ $
Where Rubber in Asphalt is specified and used in some form of pavement application.
Use of asphalt rubber in China in 2010

Among the 34 provinces (autonomous regions and municipalities directly under the central government) in China, about 22 provinces have used or are using asphalt rubber, and about 4 provinces plan to use asphalt rubber next year.

Until 2010, projects asphalt rubber may exceed 1500km, and about 100 thousand tones asphalt rubber has been used.
Brazil AR Project RJ 122 – IRF 2012 Award

- PAVEMENT CONDITIONS BEFORE AND AFTER THE REHABILITATION JOB WITH AR:
Thanks
For more information
www.rubberpavements.org
www.RA-Foundation.org