Asphalt Rubber Research and Performance

George B. Way, P.E.
Chairman RPA TAB
Retired from Arizona DOT after 35 Years

Asphalt-Rubber 101, The Basics of Rubberized Asphalt
El Paso, Texas
July 24, 2008
Charles McDonald
Inventor of
Asphalt Rubber

Early Development

McDonald
Applying
AR Band Aid
Patch
Circa 1966

Asphalt Rubber
Band Aid
Patch
Circa 1966
Phoenix, Arizona failed streets in the 1960’s. McDonalds goal to maintain failed streets until reconstruction.
Early Asphalt Rubber
Chip Seal
Circa 1970

Early Asphalt Rubber
Slurry Seal Application
Circa 1970
Early Chip Seal Spray Application Of Asphalt Rubber Circa 1975

Early Chip Seal Conveying Crumb Rubber Into Distributor Truck Circa 1975
By Early 1980’s Numerous Research Reports On Asphalt Rubber Seal Coats, SAM’s & SAMI’s Documenting Reducing Reflective Cracking
By 1985 AR Mix Design Research & Development, Gap Graded & Open Graded

- Reduce Reflective Cracking
- More Durable Surface
- Reduce Raveling
- Good Rut Resistance
- Good Skid Resistance
- Good performance in Hot & Cold Climates
Cracking
Raveling
1990’s Development of AR Standards
Arizona and ASTM

80 percent Asphalt
20 percent Ground Tire Rubber

Rubber & Asphalt Mixed together hot to form a binder

Binder pumped into plant and mixed with hot aggregate, hot mix paved as normal

Complies with ASTM 6114 Asphalt-Rubber Spec.
AR Open Graded (ARFC) and Gap Graded (ARAC)
Develop Standard Gradations

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

ARAC
Asphalt Rubber Gap Graded Mix
7.3 % Asphalt
Air Voids 5.2 %
20.2 % VMA

74u 425u 2.36 mm 6.4 mm 12.5 mm 19 mm

AR Open Graded (ARFC) and Gap Graded (ARAC)
Develop Standard Gradations
Arizona DOT % Cracking vs. Years of age

Graph showing the percentage of cracking vs. years of age for different types of asphalt mixes:
- HMA (Highway Mastic Asphalt)
- AR (Aggregates Rubble)

HMA Dense graded mixes
AR mixes
SHRP Research
I-40 After
Asphalt Rubber
Overlay of Concrete
I-40 SHRP test section
50 mm asphalt rubber placed in 1990
Pavement condition in 1998
Virtually no cracks

I-40 SHRP test section
100 mm dense graded
Mix placed in 1990
Cracked pavement condition
In 1998
<table>
<thead>
<tr>
<th>2 in AR-GAP</th>
<th>4 In PG 70-22 HMA Control</th>
<th>Air Blown LG</th>
<th>CR-TB TP</th>
<th>PG 70-22 + Fibers</th>
<th>PG 70-22 SBS 64-40 Air Blown SBS LG TP</th>
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<td>3 6 In</td>
<td>4 5 6</td>
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**7 Asphalt Binders**

**ALF FHWA Fatigue Cracking Experiment Performance of Modified Asphalts 2004**
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<th>Lane</th>
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<th>Miles</th>
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<td>Lane 3</td>
<td>Air Blown</td>
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<tr>
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<tr>
<td>Lane 6</td>
<td>TP</td>
<td>200,000</td>
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Mu Meter test values all values above 45 good skid resistance
Texas Research on Reduce Splash & Spray
Asphalt Rubber Friction Course ARFC

Concrete

California & Arizona Research on Noise AR Open Graded Quietest Surface
HMA Dense Graded Average Overlay Thickness
140 mm – 5.5 Inches

Arizona Use of AR Mixes

Asphalt Rubber Hot Mixes
Average OverlayThickness
45 mm – 1.7 Inches

HMA % of Miles With Fatigue Cracking
20 %

Asphalt Rubber % Of Miles With Fatigue Cracking
2 %
Arizona DOT Pavements Surfaced With Asphalt Rubber since 1988

About 45% Of ADOT System Paved With Asphalt Rubber

Over 20 Million Tires Recycled Since 1988

Asphalt Rubber Paved Surfaces 1988-2007
20000 Lane Kilometers

Arizona DOT Pavements Surfaced With Asphalt Rubber since 1988

\[ Y = 97.5 + 3.1^*(X) \]
\[ R^2 = 0.967 \]
\[ N = 15 \]

\[ Y = 203 + 2.7 \times (X) \]

\[ R^2 = 0.955 \]

\[ N = 15 \]

Asphalt Bid Price per Ton in Dollars

AR Percent Greater Than Asphalt

15 Data Points

2008
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<td>Asphalt</td>
<td>AR Binder</td>
<td>Difference</td>
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<td>Bid Price/Ton, US $</td>
<td>Bid Price/Ton, US $</td>
<td>AR Greater Than Asphalt</td>
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# Total Mix Costs in Dollars, June 2008

<table>
<thead>
<tr>
<th>Mix</th>
<th>Bid Price per Ton</th>
<th>Cost per Square Yd/Inch</th>
<th>Cost per Square Meter/25 mm</th>
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<tbody>
<tr>
<td>HMA Dense</td>
<td>$79</td>
<td>$4.30</td>
<td>$4.66</td>
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<tr>
<td>ARAC Gap</td>
<td>$94 (+16%)</td>
<td>$5.00 (+16%)</td>
<td>$5.42 (+16%)</td>
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<tr>
<td>ACFC Open</td>
<td>$75</td>
<td>$3.43</td>
<td>$3.72</td>
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<tr>
<td>ARFC Open</td>
<td>$82 (+9%)</td>
<td>$3.75 (+9%)</td>
<td>$4.05 (+9%)</td>
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Arizona Asphalt Rubber Benefits

Less Reflective Cracking
Less Maintenance/More Durable
Less Raveling
Good Rut Resistance
Good Skid Resistance
Smooth Ride, Less Noise
Good in hot & cold climates
Less Splash & Spray Better Drainage
Cost Effective, Energy Efficient
Good Engineering Use for Old Tires
ASTM Standard Type Asphalt
Then

NOW

Asphalt Rubber 2006 Conference
ARFC in China
Open Graded
ARAC in China
Lawrence of China? Gobi Desert George?
Thank You