ASPHALT RUBBER INTERLAYER BENEFITS

Rubber Pavement Association

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Shakir Shatnawi, Ph.D., P.E.

President, SHATEC ENGINEERING CONSULTANTS, LLC
(Former Caltrans State Pavement Engineer)
sshatnawi@shatec.net
916-990-6488
Presentation Outline

• Benefits of Asphalt Rubber
• Asphalt Rubber Chip Seal/Interalyers
• Composite Layering Systems
• Finite Element Simulations
• Conclusions and Final Remarks
Benefits of Asphalt Rubber

• From binder
  – Increased viscosity
  – Increased elasticity and resilience

• From mixes
  – Improved durability
  – Improved resistance to fatigue and reflective cracking

• Others
  – Reduction in tire-pavement noise
  – Better chip retention in chip seals
  – Using waste products (scrap tires)
Chip Seals

• Known as ARAM – Asphalt Rubber Aggregate Membrane

• A quality AR Chip Seal has the ability to resist reflective cracking

• Can fill and bridge cracks

13 year old ARCS
Interlayers (ARAMI/SAMI-R)

- Increase reflective crack resistance
- Can fill and bridge cracks
- Provide thickness equivalencies
Composite Layering Systems

- Cape Seals
- Two Layer System
- Three Layer System
AR Cape Seals

- ARAM overlaid by slurry seal
- For residential streets
- Have been used by local agencies since the mid 1980's
Two Layer System

- ARAM overlaid by ARHM or conv. AC
- For arterial streets
- Have been used by local agencies since the mid 1980’s
Two Layer System

*EXCEPT AS OTHERWISE SPECIFIED
Three Layer System

- ARAM overlaid by ARHM
- For arterial streets
- Have been used by local agencies since the mid 1980’s
Three Layer System

- 3/8” ARAM
- 0.1’ ARHM–GG
- 3/8” LIP
- 3/4” LEVELING COURSE
- EXIST. A.C.
- COLD MILL 1'
Previous Studies

• Nick Coetzee and Carl Monismith (1978)
• Chin et al (1982)
• Bin et al (2009)
### Laboratory Simulations

*(Bin et al., 2009)*

<table>
<thead>
<tr>
<th>Interlayer Type</th>
<th>Average Cycles to Failure</th>
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<tbody>
<tr>
<td>Without an interlayer (control test)</td>
<td>13,440</td>
</tr>
<tr>
<td>SBS modified asphalt sand</td>
<td>19,360</td>
</tr>
<tr>
<td>Asphalt rubber sand</td>
<td>21,993</td>
</tr>
<tr>
<td>Fiber glass polyester mat</td>
<td>23,189</td>
</tr>
<tr>
<td>SAMI-R</td>
<td>26,068</td>
</tr>
</tbody>
</table>
Finite Element Analysis

- 108 Combinations
- The Von Mises stress calculated from principal stresses according to the following equation:

\[
\sigma_{VM} = \sqrt{\frac{(\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_1 - \sigma_2)^2}{2}}
\]
Overlay System with ARAMI
Simulated Cases

Case 1-6

Overlay

0.3 mm
0.25 mm X Point 1

Crack

Case 7-18

Overlay

Point 3

Point 2

ARAMI

0.3 mm
0.25 mm X Point 1

Crack
Simulated Cases

Case 18-24

Overlay

Leveling

Point 3

Point 2

0.3 mm

0.25 mm

× Point 1

Crack

Case 25-36

Overlay

Leveling

ARAMI

Point 5

Point 4

Point 3

Point 2

0.3 mm

0.25 mm

× Point 1

Crack
Finite Element Model Schematic

Crack #

10 9 8 7 6 5 4 3 2 1

0.69 MPa

Overlay

Existing asphalt layer

Granular base

Subgrade
Von Mises Strains
Von Mises Strains
Stresses at Bottom of Overlay
Flexible Pavement Case
Strain Benefits
Relative Strain After ARAMI
Flexible Pavement Case
Strain Benefits
Relative Strain After ARAMI
Rigid Pavement Case
Fatigue Model

RHMA-G (formerly RAC-G)
\[ N_f = 1.1376 \times 10^{20} \varepsilon_{VM}^{-4.9761} \]

HMA (formerly DGAC)
\[ N_f = 2.1597 \times 10^{21} \varepsilon_{VM}^{-5.9300} \]
Fatigue Predictions Using Conventional Transfer Function

Flexible Pavement Case

![Graph showing fatigue life (repetitions) for different pavement conditions](image)
Fatigue Predictions Using Conventional Transfer Function

Rigid Pavement Case

![Graph showing fatigue life (repetitions) vs. HMA overlay thickness (cm).]
Significant Results

• A stress reduction as high as 92% in flexible pavements was achieved with the use of ARAMI compared to non-ARAMI system; and in no case was the reduction less than 55%.

• In rigid pavements, the reduction in stress was even greater; ranging from 92% to 98%. Soft ARAMI’s were found to be more effective in reducing stress and strain levels compared to hard ARAMI’s.

• In flexible pavement rehabilitation, the reduction in stress with the use of ARAMI is more emphasized with less stiff HMA overlay than with stiffer HMA.

• In rigid pavements, the effect of stiffness was not as pronounced but the use of ARAMI and leveling course was very beneficial in lowering the strain levels and in increasing pavement life.
Final Remarks

• Significant Benefits for SAM-R.
• Thin & flexible overlays benefit the most from ARAMI.
• Composite Layering Systems are superior strategies over conventional strategies.
• Premium rehabilitation strategies are those that use a combination of asphalt rubber overlays and ARAMI.
• The finite element results confirm field performance and laboratory simulations as well as previous analytical studies.
Thank You

Questions?