TIRE / PAVEMENT NOISE CHARACTERISTICS OF WEARING COURSE ASPHALT MIXTURES

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PRESENTATION OUTLINE

- Research Objective
- Discussion on Asphalt-Rubber
- Interstate – 10 Wearing Course Test Sections
  - Background
  - Pavement Types
  - Pavement Mix Design
- Field Noise Studies
  - Scofield, 2002
  - Carlson et al, 2007
  - Dynatest Inc. 2008
- Conclusions & Future Research

Portorož, Slovenia
OBJECTIVE

Evaluate tire / pavement noise characteristics of five different pavement wearing courses placed as test sections on the Interstate-10, Arizona, by means of field noise measurements.
Asphalt-Rubber (binder/bitumen)

- Components
  - 80% Asphalt (Bitumen)
  - 20% Ground Tire Rubber

- Common Surface in Arizona
  - A-R Asphalt Concrete Friction Course

Portorož, Slovenia
Scrap tires are collected for processing
Scrap Tires are Shredded and Granulated

Portorož, Slovenia
Steel and Fiber are Removed

Portorož, Slovenia
Crumb Rubber

Minus No. 10 mesh is used; free of wire and other contaminants; up to 0.5% fiber.
Asphalt-Rubber Blending Equipment

Portorož, Slovenia
Rubber is loaded into Weigh Hopper

Portorož, Slovenia
By Adding Rubber to the Bitumen, The Rubber is Able to Absorb and Retain the Aromatic Oils in Asphalt
Asphalt-Rubber and Polymer Modified Bitumen
A-R Can Be Used Anywhere Asphalt Is Used
Arizona Desert Areas

Mountain Areas

Portorož, Slovenia
I-10 WEARING COURSE EXPERIMENT

- Arizona DOT Preventive Maintenance Pavement Preservation Experiment – 1999
- Mile Post 186.2 to 195.3 East Bound
- Annual Daily Traffic (ADT) ~ 60,000 with 25% trucks
- Total Equivalent Single Axle Loads (ESALs) ~ 26 Million
- 5 Asphalt Concrete Pavement Types as Test Sections
- 32 Replicate Test Cells
SCHEMATIC OF I-10 TEST SECTIONS
Picture of Dense Gradation and ARFC

Portorož, Slovenia
WEARING COURSE PAVEMENT TYPES

- Asphalt Rubber Open Graded Friction Course (AR-ACFC)
- ADOT Standard Open Graded Friction Course (ACFC)
- Polymer Modified Open Graded Friction Course (P-ACFC)
- Permeable European Mixture (PEM)
- Stone Matrix Asphalt (SMA)

<table>
<thead>
<tr>
<th>Size</th>
<th>AR-ACFC</th>
<th>ACFC</th>
<th>P-ACFC</th>
<th>PEM</th>
<th>SMA</th>
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<tbody>
<tr>
<td>3/4</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1/2</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>80-90</td>
<td>100</td>
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<tr>
<td>3/8</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>35-60</td>
<td>70-90</td>
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<tr>
<td>No. 4</td>
<td>30-45</td>
<td>35-55</td>
<td>35-55</td>
<td>10-25</td>
<td>30-50</td>
</tr>
<tr>
<td>No. 8</td>
<td>4-8</td>
<td>9-14</td>
<td>9-14</td>
<td>5-10</td>
<td>20-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-2.5</td>
<td>0-2.5</td>
<td>0-2.5</td>
<td>0-2.5</td>
<td>8-13</td>
</tr>
<tr>
<td>AC (%)</td>
<td>9.2</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Binder Grade</td>
<td>PG 76-22+</td>
<td>PG 64-16</td>
<td>PG 76-22+</td>
<td>PG 76-22+</td>
<td>PG 76-22+</td>
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### Materials and Air Voids (2008)

<table>
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<tr>
<th>Material</th>
<th>Air Void Percentage</th>
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<tbody>
<tr>
<td>AR-ACFC</td>
<td>17.7%</td>
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<tr>
<td>SMA</td>
<td>9.65%</td>
</tr>
<tr>
<td>P-ACFC</td>
<td>20.96%</td>
</tr>
<tr>
<td>PEM</td>
<td>17.14%</td>
</tr>
<tr>
<td>ACFC</td>
<td>16.6%</td>
</tr>
</tbody>
</table>

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Portorož, Slovenia
AR-ACFC ¾” (19 mm)

Portorož, Slovenia

December 2007
SMA ¾” (19 mm)
P-ACFC ¾” (19 mm)

December 2007
PEM 1 ¼" (32 mm)

December 2007
ACFC ¾” (19 mm)
TIRE / PAVEMENT NOISE STUDIES

OBSI NOISE MEASUREMENTS

- Scofield, 2002:
  - Fall 2002
  - Arizona’s QPP
  - AR-ACFC Quietest

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Sound Intensity at 60 MPH</th>
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</thead>
<tbody>
<tr>
<td>AR-ACFC</td>
<td>98.90</td>
</tr>
<tr>
<td>ACFC</td>
<td>99.80</td>
</tr>
<tr>
<td>P-ACFC</td>
<td>100.60</td>
</tr>
<tr>
<td>PEM</td>
<td>101.00</td>
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<tr>
<td>SMA</td>
<td>99.80</td>
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- Dynatest, Inc. 2008:
  - March 2008
  - CA – AZ Noise Study
  - AR-ACFC Quietest
  - P-ACFC Loudest

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Sound Intensity at 60 MPH</th>
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<tbody>
<tr>
<td>AR-ACFC</td>
<td>99.94</td>
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<tr>
<td>ACFC</td>
<td>102.84</td>
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<tr>
<td>P-ACFC</td>
<td>104.68</td>
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<tr>
<td>PEM</td>
<td>101.56</td>
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<tr>
<td>SMA</td>
<td>102.17</td>
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</table>
ADOT CPX Trailer (Scofield 2002)
Dynatest OBSI Configuration 2008

Portorož, Slovenia
CARLSON ET AL, 2007:

- Fall (December) 2007; ADOT ↔ RPA ↔ ASU
- OBSI technique was not used
- A hand held noise meter attached to the running board of a van
- Noise meter in close proximity to the tire / pavement interface
- A similar technique used historically in AZ (early 1990’s)
AzDOT Method 1995
Spot Check 2007
Portorož, Slovenia
Sound meter calibrated to measure sound intensity in the range of 80 to 130 decibels (dB)

A computer connected to the sound meter to store the data

Stored data transferred to a PC via an RS-232 interface and analyzed using the system software

4 runs performed at three different speeds

- 60 MPH (100 Km/h)
- 72 MPH (120 Km/h)
- 75 MPH (135 Km/h)

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Sound Intensity at 60 MPH</th>
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<tbody>
<tr>
<td>AR-ACFC</td>
<td>102.40</td>
</tr>
<tr>
<td>ACFC</td>
<td>104.77</td>
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<td>P-ACFC</td>
<td>104.98</td>
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<td>PEM</td>
<td>102.69</td>
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<tr>
<td>SMA</td>
<td>104.48</td>
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2007 Measured at 60 MPH
Dynatest 2008 at 60 MPH
Scofield-Donovan 2002 at 60 MPH
Percent Cracking Guide

Portorož, Slovenia
Raveling a Scale from 1 (best) to 5 (worst)
Surface Distress

![Bar chart showing surface distress with ARACFC, SMA, PACFC, PEM, and ACFC categories. The chart compares percent cracking and raveling for each category. Portorož, Slovenia.]
<table>
<thead>
<tr>
<th>Section</th>
<th>Distress</th>
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<tbody>
<tr>
<td>1. AR ACFC</td>
<td>3.2</td>
</tr>
<tr>
<td>2. SMA</td>
<td>10.5</td>
</tr>
<tr>
<td>3. PEM</td>
<td>14.2</td>
</tr>
<tr>
<td>4. ACFC</td>
<td>14.7</td>
</tr>
<tr>
<td>5. Polymer ACFC</td>
<td>19.5</td>
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</tbody>
</table>
Noise (OBSI 2008) and Distress

Portorož, Slovenia
CONCLUSIONS

  - 1. AR-ACFC
  - 2. ACFC & SMA
  - 3. SMA
  - 4. P-ACFC
  - 5. PEM
  - 1. AR-ACFC
  - 2. PEM
  - 3. SMA
  - 4. ACFC
  - 5. P-ACFC

- 2007 spot check technique agrees with 2008 OBSI measurements, in terms of rank. Difference ~1.5 dB

- Noise level of each test section appeared related to the degree of surface deterioration
  - AR-ACFC experienced the least cracking and wear after 8 years of service

Future Work: Field Cores collected will be used for laboratory Noise Evaluation

Portorož, Slovenia
Questions & Comments