## Samples

<table>
<thead>
<tr>
<th></th>
<th>SAMPLE A</th>
<th>SAMPLE B</th>
<th>SAMPLE C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>% Wt. of AR Binder</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Asphalt</strong></td>
<td>PG 70-10</td>
<td>76</td>
<td>PG 64-16</td>
</tr>
<tr>
<td><strong>Extender Oil</strong></td>
<td>Supplier A</td>
<td>2</td>
<td>Supplier A</td>
</tr>
<tr>
<td><strong>CRM Scrap Tire</strong></td>
<td>Supplier A</td>
<td>17</td>
<td>Supplier A</td>
</tr>
<tr>
<td><strong>CRM High Nat</strong></td>
<td>Supplier A</td>
<td>5</td>
<td>Supplier A</td>
</tr>
<tr>
<td><strong>Binder/Rubber</strong></td>
<td>Ratio</td>
<td>78/22</td>
<td>Ratio</td>
</tr>
</tbody>
</table>

- **a** asphalt from 3 different suppliers
- **b** Extender oil from same supplier for the three samples
- **c** CRM source from two suppliers
- **d** Each sample (A,B,C) field produced by a different supplier in California

The three materials were field produced by different suppliers, all according to Caltrans Section 39-3.02 for Asphalt Rubber Binder for Rubber Hot Mix Asphalt.
# Current Specifications

<table>
<thead>
<tr>
<th>Test Performed</th>
<th>45 Minute Rx Time</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAMPLE A</td>
<td>SAMPLE B</td>
</tr>
<tr>
<td>Cone Penetration, 77F, dmm, (D217)</td>
<td>N/A</td>
<td>57</td>
</tr>
<tr>
<td>Resilience at 77F, %, (D5329)</td>
<td>N/A</td>
<td>32</td>
</tr>
<tr>
<td>Softening Point, degF (D6)</td>
<td>N/A</td>
<td>146</td>
</tr>
<tr>
<td>Viscosity, Haake at 375F, cP, (LP-11)</td>
<td>N/A</td>
<td>2900</td>
</tr>
</tbody>
</table>
Protocol

- Written procedures were given out
- An excel spread sheet was provided for entering data
- All samples were tested in triplicate
- Model and software was asked about each equipment
- Notes section was added
- Samples are all field samples, which were mixed together then poured up
Observations

- DSR looks more reproducible as the binder ages
- AASHTO reproducibility were placed on the graphs and show that most of the data would fall within published ranges.
- ASTM was used for Elastic Recovery and results don’t look very good, maybe method needs to be modified for better results
- BBR m value don’t look bad
- BBR stiffness does not look good but the numbers are very low, maybe the reproducibility is not as good when the numbers are low. Most of the studies looked at so far have number ranging from 100 to 280.
Data

- Northwest Analytical is the software package used
- Some of the data was considered to be outliers and marked in the program as such
- The Mass Change is included but should not be used as many people did not remove the data. I don’t have the raw data so I am not sure if the sample came out of the bottles during the RTFO or they just did not do it
- There are some other methods to get mass change and PAV testing, which are not included in this initial report.
- The material did separate slightly during the PAV
Sample A Org. G*/sinDelta

File: PCCAS Asphalt Rubber Binder.DAT
Org G*/sinDelta

Individual: cl: 2.225116  ucl: 3.035156  lcl: 1.415077
Sample A ORG. G*/sinDelta
Sample A ORG. $G^*/\sin\Delta$
Sample A Org. G*/sinDelta

File: PCCAS Asphalt Rubber Binder.DAT
Org G*/sinDelta

Samples: 43  Skewness: 0.42859
Mean: 2.225116  Std Dev.: 0.237311
Kurtosis: 2.5238
Sample A Org. G*
Sample A Org. G*
Sample A Org. Phase Angle
Sample A Org. Phase Angle

File: PCCAS Asphalt Rubber Binder.DAT

Org Phase Angle

Samples: 44  Skewness: -0.90095
Mean: 69.67727  Std Dev: 2.818945  Kurtosis: 3.8077
Sample A RTFO $G^*/\sin\Delta$
Sample A ORG. $G^*/\sin \Delta\text{ vs } G^*$
Sample A RTFO G*/sinDelta

File: PCCAS Asphalt Rubber Binder.DAT

RTFO G*/sinDelta

Samples: 44  
Mean: 4.496818  
Std Dev.: 0.7492159  
Skewness: 0.51504  
Kurtosis: 2.4997
Sample A RTFO G*
Sample A RTFO G*
Sample A RTFO Phase Angle
Sample A RTFO G*/sinDelta vs G*

File: PCCAS Asphalt Rubber Binder.DAT

RTFOGSIN (X) vs. RTFOG (Y)
Sample A RTFO Phase Angle

File: PCCAS Asphalt Rubber Binder.DAT
RTFO Phase Angle

Samples: 44  Skewness: -0.63189
Mean: 61.78182  Kurtosis: 3.424
Std Dev: 2.15884
Sample A Mass Change
Sample A Mass Change

File: PCCAS Asphalt Rubber Binder.DAT
Mass Change

Samples: 35  Skewness: -0.41695
Mean: -0.2846571  Std Dev: 0.152417
Kurtosis: 3.4558
Sample A Elastic Recovery

File: PCCAS Asphalt Rubber Binder.DAT
Elastic Recovery
Sample A Elastic Recovery

File: PCCAS Asphalt Rubber Binder.DAT
Elastic Recovery

Samples: 35  Skewness: 0.77555
Mean: 84.39857
Std Dev: 3.129755  Kurtosis: 4.6105
Sample A PAV DSR G*\sinDelta
Sample A PAV G*sinDelta

File: PCCAS Asphalt Rubber Binder.DAT
PAV DSR G*sinDelta

Samples: 44
Mean: 468.3409
Std Dev: 167.8812
Skewness: 0.35503
Kurtosis: 3.5062
Sample A PAV DSR G*
Sample A PAV DSR G*

File: PCCAS Asphalt Rubber Binder.DAT

Mean

-2s

+2s

Samples: 41  Skewness: 0.56353
Mean: 714.8203  Std Dev.: 227.7198  Kurtosis: 3.4657
Sample A PAV DSR $G^*\sin\Delta$ vs $G^*$

File: PCCAS Asphalt Rubber Binder.DAT

PAVGSIN (X) vs. PAVG (Y)
Sample A PAV DSR Phase Angle
Sample A BBR m value
Sample A BBR m value

File: PCCAS Asphalt Rubber Binder.DAT

BBR m value

Samples: 31
Mean: 0.3271935
Std Dev: 0.01795814
Skewness: 0.10172
Kurtosis: 4.0605

Mean

AASHTO

-2s

+2s
Sample A BBR stiffness
Sample A BBR stiffness

File: PCCAS Asphalt Rubber Binder.DAT
BBR stiffness

Samples: 29
Mean: 48.96552
Std Dev: 10.45221
Skewness: -0.20825
Kurtosis: 1.9472
Sample B ORG $G^*$/sin$\Delta$
Sample B ORG $G^*/\sin\Delta$
Sample B ORG G*
Sample B ORG G
Sample B ORG Phase Angle

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B ORG Phase Angle

Individual: cl: 69.35  ucl: 88.45833  lcl: 53.24167
Sample B ORG Phase Angle

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B ORG Phase Angle

Samples: 44  Skewness: -0.89809
Mean: 69.35  Std Dev: 5.389444  Kurtosis: 4.1326
Sample B RTFO $G^*/\sin\Delta$
Sample B RTFO G*/sinDelta

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B RTFO G*/sinDelta

Samples: 44  Skewness: -0.0017258
Mean: 2.471591  Kurtosis: 2.1009
Std Dev: 0.5209515
Sample B RTFO G*
Sample B RTFO Phase Angle
Sample B Mass Change

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Mass Change

Individual: cl: -0.3070357  ucl: 0.2303608  lcl: -0.8444322
Sample B Mass Change

File: PCCAS Asphalt Rubber Binder Sample B.DAT

Mass Change

Samples: 28
Mean: -0.3070357
Std Dev: 0.1791322
Skewness: -0.29096
Kurtosis: 3.4813

Mean
-2s
+2s
Sample B Elastic Recovery

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Elastic Recovery

Individual: cl: 81.05294  ucl: 94.40153  lcl: 67.70435
Sample B Elastic Recovery

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Elastic Recovery

Samples: 34  Mean: 81.05294
Skewness: 0.67587  Std Dev: 4.449531
Kurtosis: 3.6985
Sample B PAV DSR G*sinDelta
Sample B PAV DSR $G^*\sin\Delta$

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B PAV DSR $G^*\sin\Delta$

Samples: 43  Skewness: -0.26968
Mean: 504.7907  Kurtosis: 2.3189
Std Dev: 119.3922
Sample B PAV DSR G*
Sample B PAV DSR G*
Sample B PAV DSR Phase Angle
Sample B PAV DSR Phase Angle

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B PAV DSR Phase Angle

Samples: 44  Skewness: 0.30536
Mean: 56.32727  Std Dev: 1.627005
Kurtosis: 2.6699
Sample B BBR m value

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B BBR m value

Individual: cl: 0.3700769  ucl: 0.4385939  lcl: 0.3015599
Sample B BBR m value

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B BBR m value

Samples: 39  
Mean: 0.3700769  
Std Dev: 0.01611372  
Skewness: 0.30383  
Kurtosis: 2.6174
Sample B BBR Stiffness

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B BBR stiffness

Individ.

cl: 99.74878  ucl: 156.777  lcl: 42.72052
Sample B BBR Stiffness

File: PCCAS Asphalt Rubber Binder Sample B.DAT
Sample B BBR stiffness

Samples: 41  Mean: 99.74878  Std Dev: 19.00942
Skewness: -0.45088  Kurtosis: 2.7428
Sample C ORG. G*/sinDelta

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C ORG G*/sinDelta

Individual: cl 1.854869 ucl 2.539198 lcl 0.7705797
Sample C ORG. $G^*/\sin\Delta$
Sample C ORG. G*
Sample C ORG. G*
Sample C ORG. Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C ORG Phase Angle

Individual: cl: 68.78605  ucl: 79.50227  lcl: 58.06982
Sample C ORG. Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C ORG Phase Angle

Samples: 43  Skewness: -1.1083
Mean:  68.78805  Std Dev:  2.641061  Kurtosis:  4.4225
Sample C RTFO $G^*/\sin\Delta$
Sample C RTFO G*/sinDelta

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C RTFO G*/sinDelta

Samples: 45
Mean: 3.153333
Std Dev: 0.5278989
Skewness: 0.080226
Kurtosis: 2.6855
Sample C RTFO G*
Sample C RTFO G*
Sample C RTFO Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT

Sample C RTFO Phase Angle

Individual: cl: 61.44  ucl: 68.55639  lcl: 54.32361
Sample C RTFO Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C RTFO Phase Angle

Samples: 45  Skewness: -0.46225  Mean: 61.44
Std Dev: 2.37213  Kurtosis: 2.6382
Sample C Mass Change
Sample C Mass Change

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C Mass Change

Mean

-2s

+2s

Samples: 36  Skewness: -0.87525
Mean: -0.3148611
Std Dev: 0.1772219  Kurtosis: 5.3382
Sample A Elastic Recovery

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C Elastic Recovery

Individual: cl: 84.50606  ucl: 93.16171  lcl: 75.85041
Sample C Elastic Recovery

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C Elastic Recovery

- Samples: 33
- Mean: 84.17273
- Std Dev: 2.436862
- Skewness: 1.4898
- Kurtosis: 6.7232
Sample C PAV DSR G*\sin\Delta
Sample C PAV DSR G*

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C PAV DSR G*

Samples: 40  Skewness: 0.91786
Mean: 567.45  Std Dev: 170.5157
Kurtosis: 4.5209
Sample C PAV DSR Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C PAV DSR Phase Angle

Individual: cl: 46.63182  ucl: 52.56332  lcl: 40.70031
Sample C PAV DSR Phase Angle

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C PAV DSR Phase Angle

Samples: 44
Mean: 46.63182
Std Dev: 1.977169
Skewness: 0.46792
Kurtosis: 4.3926
Sample C BBR m value
Sample C BBR m value

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C BBR m value

Samples: 39  Skewness: 0.35838
Mean: 0.3415385
Std Dev: 0.01034623  Kurtosis: 2.4894
Sample C BBR Stiffness

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C BBR Stiffness

Sample C BBR Stiffness

File: PCCAS Asphalt Rubber Binder Sample C.DAT
Sample C BBR Stiffness

Samples: 39  Skewness: -0.56568
Mean: 65.64103  Kurtosis: 2.756
Std Dev: 10.37131