5.0 Inspection Guide

Operation, Production, and Trouble Shooting

AC Plant Operations

Plant operations during RAC mix production are essentially the same as for standard AC mix production. CT 109 requirements apply.

Differences
- Production and monitoring of the asphalt rubber binder for wet process mixes.
- Plant mixing temperatures of 300-325°F may be slightly higher than usual.

AR Binder Production

Required Documentation
- AR Binder Design Profile, including
  - Component identification and proportions
  - CRM gradations
  - AR test results showing compliance with specifications
- Certificates of Compliance for components
  - Asphalt Cement
  - Asphalt Modifier (Extender Oil)
  - Scrap Tire CRM
  - High Natural CRM
Asphalt Rubber Blend Design
Example Design Profile

<table>
<thead>
<tr>
<th>TEST</th>
<th>Minutes of Reaction</th>
<th>Spec. Limits @ 45 minutes (Caltrans 12/2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, cp Haake @ 190°C</td>
<td>45 90 240 360 1,440</td>
<td>1,440</td>
</tr>
<tr>
<td>R &amp; B Softening</td>
<td>2400 2800 2800 2800 2100</td>
<td>1,500 - 4,000</td>
</tr>
<tr>
<td>25ºC (% Rebound)</td>
<td>27 -- 33 -- 23</td>
<td>18 Minimum</td>
</tr>
<tr>
<td>(ASTM D3209)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resilience @ 25ºC (%)</td>
<td>59.0 59.5 59.5 60.0 58.5</td>
<td>59 – 74</td>
</tr>
<tr>
<td>(ASTM D5329)</td>
<td></td>
<td>(125-165°F)</td>
</tr>
<tr>
<td>Cone Pen @ 25ºC</td>
<td>30 46 -- 50</td>
<td>25 – 70</td>
</tr>
<tr>
<td>(ASTM D317)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AR Binder Production

Inspection items
- Batch sheets or production logs for AR binder that show the amounts (typically by mass) of the components used. Check proportions of:
  - Asphalt Cement
  - Extender oil
  - Scrap tire CRM
  - High natural CRM

AR Binder Production

The AR binder production logs or viscosity testing logs should indicate when the CRM was added.

Before adding AR binder to the aggregate:
- Verify minimum AR interaction time of 45 minutes has elapsed
- Verify AR binder viscosity meets or exceeds the minimum 1,500 cPs requirement at 375°F
- Continue to monitor viscosity hourly during RAC mix production
AR Binder Production

Follow sampling and testing frequency requirements listed in the project special provisions for AR binder and individual components.

- Typically, at least one one-gallon sample should be obtained from each batch of binder produced.
- Of these, some samples would be randomly selected and tested for specification compliance.
- Take additional samples if any changes or discrepancies are observed in any of the materials.

AR Binder Production

As long as interaction time and viscosity meet or exceed minimum requirements, the AR binder may be added to the aggregate, even if viscosity differs from values shown in the design profile.

The design profile serves as a guide, not as a specification. If viscosity during production differs from design profile by 400 cPs or more for corresponding interaction interval, obtain a binder sample for compliance testing.

AR Binder Production

If viscosity falls below the minimum limit of 1500 cPs, the AR binder cannot be used to make RAC.

To restore viscosity, the AR binder producer may add up to 10% more CRM (using the design ratios of scrap tire and high natural CRM) by total binder mass.

- The amount of CRM added shall be documented.
- An additional 45 minute interaction period is required after CRM addition.
- Viscosity of the “adjusted” AR binder must comply with viscosity specifications in order to proceed with RAC mix production.
RAC Mix Production

Required Documentation
- RAC Mix Design including:
  - Individual and combined aggregate gradations
  - Results of individual and combined aggregate quality tests
  - Aggregate source(s) and blend proportions
  - Theoretical maximum specific gravity/density
  - Design AR binder content
  - Design air voids content
  - Design VMA
  - Hveem Stability

RAC Mix Production
- Verify AC plant complies with CT 109 requirements.
- Check aggregate bins.
- Sample aggregate cold feed or hot bins as appropriate and verify gradation. Test Sand Equivalent as required.
- Verify RAC mixing and discharge temperatures.
- Visually inspect the RAC mix in the haul truck before it leaves the plant.
- Sample and test RAC mix according to the project special provisions. Tests include gradation, AR binder content, maximum theoretical specific gravity, lab-compacted air voids, and Hveem stability.

RAC Mix Production
- Verify that haul trucks are tarped.
- Maintain inspector's log of pertinent information, including but not limited to:
  - List of samples obtained
  - Plant test results (aggregates and mix)
  - Quantities of AR binder and RAC mix
  - Binder production temperatures and viscosity measurements, etc.
  - Other required information
RAC Mix Production

- May use Caltrans Form CEM-3501, AC Production/Placement Checklist modified for RAC
  - See handout example

Inspection at Paving Site

Before Overlay Placement:

- Verify surface preparation is complete
  - Cracks treated or sealed?
  - Damaged areas repaired?
  - Milling properly completed (if applicable)?
  - Surface clean and swept?
  - Tack coat properly applied?
- Verify ambient and pavement temperatures are at least 55ºF and rising

Inspection at Paving Site

- Equipment
  - Verify that paver and rollers meet size requirements, are in good working condition, and qualified operators are on-site
  - Verify sufficient steel-tired rollers are available for breakdown and intermediate compaction.
  - Breakdown rollers must have vibratory capability
- Delivery method: Do not use windrows if ambient temperature is marginally cold.
Inspection at Paving Site

Caltrans requirements for RAC-G, ambient temperature <65°F:
- RAC-G spread temperature 290-325°F
- Minimum temperature for breakdown rolling is 280°F
- Vibratory mode is required for RAC-G breakdown
- Complete breakdown before RAC mat temperature drops below 260°F

Inspection at Paving Site

- Less stringent for ambient temperature ≥ 65°F
- Other jurisdictions recommend minimum 290°F for breakdown rolling or completion thereof
- Compaction requirements will be implemented for RAC-G mixes in the future, with acceptance based on cores

Inspection at Paving Site

Caltrans placement temperature requirements for RAC-O and RAC-O-HB ambient temperature <65°F are the same as for RAC-G.

Other jurisdictions do not recommend placing RAC-O at temperatures <68°F.

For open-graded RAC mixes, use static mode for breakdown compaction. Do not use vibratory mode. Percent compaction is not a requirement for open-graded mixes.
Inspection at Paving Site

During RAC placement:
- Collect load tickets and track tonnage placed
- Measure placement thickness and calculate yield
- Observe coordination between RAC delivery and placement – record if trucks or paver are waiting
- Note any rejected loads of RAC
- Observe delivery operations - are good practices being used?

Inspection at Paving Site

- Record if windrows are used.
- Monitor RAC temperatures at spread and during breakdown and intermediate compaction.
- Observe paver operations – note discrepancies from good practice that might impact quality of joints or ride (smoothness).
- Joints at proper locations?
- Observe raking, luting, handwork. Broadcasting of excess mix or over-raking will damage the appearance of the finished pavement.

Inspection at Paving Site

- Observe compaction operations – note discrepancies from good practice that might impact in-place density
  - Breakdown roller(s) following immediately behind paver?
  - Breakdown roller(s) using vibratory mode?
  - Sufficient breakdown rollers operating to keep up with paver?
  - Intermediate static roller(s) keeping up?
  - Finish rollers effective?
Inspection at Paving Site

Rules of Thumb for RAC-G compaction:

- Need to get 95% of minimum required density with breakdown coverages to achieve adequate compaction.
- Mix temperature is critical for adequate compaction of RAC-G materials.

After Paving

- Check the appearance of the finished surface for roller marks, scuffs, gouges, or other irregularities.
- Check smoothness as required in project special provisions.
- Visually evaluate quality of paving joints and identify any areas that may need to be sealed.
- Identify core locations for compaction acceptance.

Troubleshooting

- If any type of RAC mix problem is suspected, obtain samples immediately and test for compliance with project special provisions.
- Log full description of problem and related activities and report to the RE.
Troubleshooting

Possible Problems to Watch For:

- Segregation: Particle size segregation may be difficult to ID in coarse graded RAC-G mixtures. May appear segregated even if not, due to small percentage of fines included.
  - When in doubt, sample
  - ID affected truckloads and corresponding placement areas for info
- Size segregation is often accompanied by temperature segregation

Troubleshooting

- Temperature segregation may be identified using a heat gun or infrared camera
  - To measure actual mix temperature without surface effects, use a 6-inch long probe
- Indicates hot and cold spots in the mix that can cause differences in compaction
  - Can see areas in haul trucks and pavers where mix is not circulating and has cooled
  - Shows when material from paver wings is dumped into the hopper and where it comes out behind the screed

Troubleshooting

- Smoke
  - Blue smoke means that the mix is too hot and plant operating temperature needs to be adjusted
  - White smoke is steam - too much moisture in the mix. May make mix tender and interfere with compaction. Aggregate needs to be dried longer before mixing with the AR binder.
Troubleshooting

Stiff appearance: Too cool or possibly somewhat low AR binder content. Check temperature and get a mix sample for further testing if needed.

Dull, flat appearance: Low AR binder content and/or excessive fines. Localized areas may indicate insufficient mixing or segregation. Get sample and test for gradation and AR binder content.

Troubleshooting

Slumped and shiny appearance typically indicates high AR binder content.

- RAC-O and especially RAC-O-HB may look this way and still meet specifications
- Old descriptive term is “wormy” – mix seems to almost crawl while watched
- Some complying RAC-G mixes may also be wormy
- Visually check for binder drain down in the haul truck bed, sample and test for AR binder content and gradation

Summary of Module 5

Changes in the plant inspector’s duties due to RAC production are limited to:

- Monitoring AR binder production and viscosity results
- Sampling AR binder and individual component materials for verification and acceptance

Changes to field inspector’s duties are very minor, primarily related to monitoring RAC temperature and compaction operations:

- Use modified CT production/placement report form
- Compaction acceptance for RAC-G will be based on cores at locations designated by Caltrans
Questions?
### ASPHALT RUBBER BINDER FORMULATION

<table>
<thead>
<tr>
<th>Asphalt Cement PG Grade and Supplier</th>
<th>Blend Proportions</th>
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</thead>
<tbody>
<tr>
<td>Asphalt Modifier Type and Supplier</td>
<td>% by AC mass:</td>
</tr>
<tr>
<td>Asphalt Cement and Modifier</td>
<td>% by Asphalt Rubber Binder mass:</td>
</tr>
<tr>
<td>Scrap Tire CRM Type &amp; Supplier</td>
<td>% by Asphalt Rubber Binder mass:</td>
</tr>
<tr>
<td>High Natural CRM Source &amp; Description</td>
<td>% by Asphalt Rubber Binder mass:</td>
</tr>
</tbody>
</table>

Asphalt Rubber Binder (ARB) material must be tested to verify compliance with minimum viscosity requirement of $1,500 \text{ Pa}\cdot\text{s} \times 10^{-3}$ at $375\pm3^\circ\text{F}$ before it can be used.

<table>
<thead>
<tr>
<th>*Cycle Start Date &amp; Time</th>
<th>AR Batch #</th>
<th>Temperature in ARB Tank (°F)</th>
<th>Temp. During Viscosity Test (°F) $(375 \pm 3^\circ\text{F})$</th>
<th>Measured Viscosity** Pa•s$(x10^{-3})$</th>
<th>Date and Time Sampled</th>
<th>Date and Time Tested</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

Viscometer Make, Model and Serial #:________________________________________________________

Rotor Designation:_____________________________________________________________________

Test Operator:________________________________________________________________________

* The cycle begins when the asphalt rubber tank is fully loaded and temperature in the tank is $375\pm3^\circ\text{F}$.

** Measure viscosity at $375\pm3^\circ\text{F}$ according to Caltrans LP-XX. Viscometer may read in units of centipoises (cPs) or dPa•s. Unit conversions are as follows:

$1\text{Pa}\cdot\text{s} = 1,000 \text{ cPs}$

$1\text{dPa}\cdot\text{s} = 0.1\text{Pa}\cdot\text{s} = 100 \text{ cPs}$

$1\text{mPa}\cdot\text{s} = 0.001\text{Pa}\cdot\text{s} = 1 \text{ cPs}$
# AC Production/Placement Checklist

## Project Identification

<table>
<thead>
<tr>
<th>Completion Date (Expected)</th>
<th>Route</th>
<th>Post Kilometers</th>
<th>Completion Date (Contract)</th>
<th>Job Suspended</th>
<th>AC (Tonnes Produced to Date)</th>
<th>AC (Tonnes Remaining)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>YES</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Problem Statement

### Mix Properties

<table>
<thead>
<tr>
<th>Type Mix</th>
<th>Type Grading</th>
<th>Max Grading</th>
<th>Additives</th>
<th>Aggregate Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Dense</td>
<td>38</td>
<td>Lime</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>Gap</td>
<td>19</td>
<td>Liquid Anti-Strip</td>
<td>B</td>
</tr>
<tr>
<td>Recycled</td>
<td>Open Graded</td>
<td>12.5</td>
<td>Cement</td>
<td>Absorptive</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>9.6</td>
<td>Other</td>
<td>Non-Absorptive</td>
</tr>
</tbody>
</table>

### Asphalt-Rubber Binder

- Base Asphalt Grade and Source:
- Asphalt Modifier (Extended Oil) Source / % Added
- Scrap Tire CRM Source / % Added
- High Natural Source / % Added

### Appearance

- OK
- Segregated
- Rich
- Dry
- Tender
- Color
- Other

### Background Data

- Actual Binder Content
- Actually Stability of Street Samples
- Test Maximum Density

### Mix Supplier and Location(s)

### Field Conditions (At Paving Operation)

<table>
<thead>
<tr>
<th>General Weather</th>
<th>Air Temperature (°C)</th>
<th>Surface Temperature (°C)</th>
<th>Mix Temp at Plant (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal</td>
<td>Clear</td>
<td>Under 4</td>
<td>Under 121</td>
</tr>
<tr>
<td>Valley</td>
<td>Cloudy</td>
<td>4-9</td>
<td>121-134</td>
</tr>
<tr>
<td>Mountain</td>
<td>Foggy</td>
<td>10-15</td>
<td>135-162</td>
</tr>
<tr>
<td>Desert</td>
<td>Rainy or Worse</td>
<td>16-20</td>
<td>163-190</td>
</tr>
<tr>
<td></td>
<td>Humid or Dry</td>
<td>21-25</td>
<td>191-204</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26-32</td>
<td>Greater than 204</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33-38</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greater than 38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Windy or Calm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Mix Temp at Window (°C)

- Under 65
- 65-89
- 90-125
- Greater than 125

### Mix Temp at Breakdown Roller (°C)

- Under 65
- 65-89
- 90-125
- 126-150
- Greater than 150

### Distance Paver to Breakdown Paver Roller (Meter)

- Under 15
- 16-76
- 76-150
- 151-229
- 230-300
- Greater than 300

### Window Length (Meter)

- 0
- 0-30
- 31-61
- 62-91
- 92-122
- 123-123-152
- Greater than 152

### Average One Way Haul Time (hours)

- Under ½
- ½-1
- 1-2
- Greater than 3
### Structural Properties

<table>
<thead>
<tr>
<th>Paint Binder</th>
<th>Tack Spread Rate (Liters per meter squared)</th>
<th>Mix Thickness (Compacted)</th>
<th>Underlying Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>0.45</td>
<td>First Lift</td>
<td>AC</td>
</tr>
<tr>
<td>Emulsion</td>
<td>0.68</td>
<td>Second Lift</td>
<td>PCC</td>
</tr>
<tr>
<td>Other</td>
<td>0.95</td>
<td>Third Lift</td>
<td>ATPB</td>
</tr>
<tr>
<td></td>
<td>1.13</td>
<td></td>
<td>AB</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

- Paver Options
  - Make
  - Model;
  - Pickup Machines
  - Screed Ext. (length)
  - Ski (length)
  - Joint Matcher
  - Grade Wire
  - Other

### Mechanical Properties

#### Nuclear Density Gage

- Method Specification or End Result Compaction Special Provision
  - Make: Calibration (date):
  - Model: Average Relative Compaction

<table>
<thead>
<tr>
<th>Breakdown Rollers</th>
<th>Intermediate Rollers</th>
<th>Finish Roller(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Type</td>
<td>Type</td>
</tr>
<tr>
<td>Weight</td>
<td>Weight</td>
<td>Weight</td>
</tr>
</tbody>
</table>

- If Vibratory Rollers are used: On Caltrans Approved List
  - Make
  - Model
  - Speed
  - Frequency
  - Amplitude
  - Actual
  - Specified

*A completed copy of this form should be filed in Category 35 of the Project Documents. A description of the original form is included in the Construction Manual.

Comments: