Focus: RAC surface courses
- RAC-G, RAC-O, and RAC-O-HB
- RAC placement very similar to typical dense-graded AC overlays, except:
  - Typically requires higher placement and compaction temperatures
  - For RAC-G, use vibratory mode for breakdown passes and get 95% of required compaction during breakdown
  - Not amenable to handwork
- Good practices are required for RAC production and construction, as for DGAC.

Goal: Provide surface conditions that promote performance of the new RAC surface.

Same activities as for DGAC:
- Address existing distress
  - Seal cracks
  - Remove and replace failed pavement
- Improve smoothness
  - Fill ruts, level, restore or adjust profile
- Assure bond with underlying layers
Surface Leveling

- **Purpose** – Restore (or improve) surface profile, fill ruts, and/or maintain curb reveal
- **Techniques**
  - Cold milling, cold planing, grinding
  - Leveling course (DGAC)
  - Rut filler

Clean and Sweep

- Remove debris from repairs, milling or grinding prior to placing overlay, to promote good bond.
- **Wash if necessary**
  - Make sure surface is dry before overlaying
- Sweep/broom thoroughly to remove possible bond breakers

Apply Tack

Purpose is to bond pavement layers together. Paving grade asphalt preferred for RAC.

Manufacture

- **Primary difference from normal AC plant operations** is on-site manufacture of high viscosity asphalt rubber binder.
  - Have already discussed binder components and design
  - Construction
  - Inspection details in next segment
  - Steps and equipment follow

AR Binder Production Process

- Blending
- Schematic
- Asphalt Storage Tank
- Ground Rubber
- Heat Tank
- Blender
- Reaction Vessel

CRM comes in nominal 2,000 lb “Supersacks”
CRM is weighed in hopper

CRM is blended with hot asphalt cement

RAC Mix Production

- Asphalt rubber binder feed is substituted for normal asphalt cement feed, interlocked and metered into the AC plant
- Little impact on AC plant operations
  - More than one AR binder plant can be used to maintain RAC production at normal tph rate
  - Primary differences from DGAC are in mixing and discharge temperatures
    - Aggregate mixing temperature range 300 - 325°F
    - AR binder added at ≈ 375°F
Mix Delivery (Hauling)

- RAC mix temperature is critical for placement and compaction
  - Trucks hauling RAC mixes must be tarped
  - Spread temperature 280-325°F per Caltrans
  - Minimum temperature for start of breakdown rolling is 275°F per Caltrans
  - Generous compared to other specifications: Green Book requires higher temperatures

Mix Delivery

- As for DGAC, to promote quality, smoothness, and uniform compaction, must balance all aspects:
  - Mix production (AC plant)
  - Mix delivery (trucking)
  - Paving operations (non stop)
  - Compaction (keep up with the paver)

Mix Segregation

- Aggregate (particle size) segregation
  - RAC-G may look segregated due to low fines content – mix texture may look coarse and somewhat open.
  - Sample, test binder content and gradation to verify
  - Segregation causes non-uniform gradation and compaction, may yield interconnected air voids
  - Sources include mix loading/unloading and paver operation

Mix Segregation

- Techniques to reduce aggregate (particle size) segregation
  - Better mix gradations – not much help for RAC-G or RAC-O
  - Improved loading and unloading practices
  - Use material transfer vehicle – not always feasible

Thermal Segregation

- Often accompanies particle size segregation
- Results in non-uniform compaction
- Sources include:
  - Processes that result in uneven cooling (hauling, windrows)
  - Managing paver wings
  - Delays in mix delivery and/or placement

Thermal Segregation

- Techniques to reduce thermal segregation
  - Minimize time between loading and placement
  - Truck insulation and tarping
  - Proper paving procedures
  - Material transfer vehicle
Issues Related to Haul Trucks

- Types and characteristics
  - End dump
  - Belly (bottom) dump – do not use windrows when site temperatures are marginally cold
  - Horizontal discharge (live bottom)
- Insulation – tarps required
- Cleaning (truck bed) – NO SOLVENTS!
  - Soap for surfactant
- Truck maintenance

Truck Loading Practices

- Primary goal – Avoid segregation!
  - What makes a mix prone to segregation?
    - Range of particle sizes, limited fines

Truck Loading Practices

Preferred practice for end dump trucks:

- Long
- Short

Preferred practice for belly dump trucks:

Placement (Laydown)

- Purpose – Place mix smoothly at a uniform specified thickness conforming to plan slopes and grades at temperatures above a specified minimum
- Equipment – same as for DGAC
  - Tractor unit (paver)
  - Screed unit
- Paver operation - same as for DGAC
- Joints – good practices essential

Paver Operation

Use good practices!

References:

- National Highway Institute (NHI) HMA Construction Course
- HMA Paving Handbook 2000
- Caltrans Construction Manual
Handwork

- Minimize as feasible
- Coarse gradation, stiff binder make handwork difficult
- High temperatures necessary to maintain RAC workability
- Typically yields coarse, open and rough looking appearance due to limited fines
- Minimize raking and luting
- Do not broadcast excess material

Joints

The same factors that make handwork difficult for RAC mixes also affect construction and finished appearance of joints.

- Use good practices
- Difficult to feather RAC mix due to limited fines
- Assume compaction reduces machine placement thickness by ≈ ¼-inch per inch difference
  - For hand placement, use 3/8-inch per inch difference
- Some raking unavoidable
  - Minimize as possible
  - Rake excess to hot side, not cold side

Joint Overlap

Key factors influencing compaction include:
- Lift thickness
- Air temperature
- Base temperature
- Spread temperature of RAC mix
- Wind velocity, humidity, & other site factors
- Sunlight or lack thereof
- Mix properties including binder content

Compaction

Adequate compaction is required to achieve good pavement performance

- Improves resistance to rutting
- Reduces moisture/air penetration and related environmental damage
  - Oxidative ageing (embrittlement, raveling)
  - Moisture damage (stripping)
- Improves fatigue resistance
- Reduces low temperature cracking potential
- Improves durability

Compaction Temperature (RAC)

- When air temperature is ≥55°F,
  - Minimum temperature for starting breakdown rolling is 280°F
  - Breakdown must be completed before mat temperature drops below 260°F
- When air temperature is ≥ 65°,
  - Minimum temperature for starting breakdown rolling of RAC-G is 275°F.
  - Breakdown must be completed before mat temperature drops below 250°F
Compaction Temperature

Caltrans temperature requirements for RAC mixes are more generous than those of other agencies.
- Specify the same temperatures for RAC-O and RAC-O-HB mixes as for RAC-G
- Working at the minimum temperatures may cause problems with achieving adequate compaction of RAC-G mixes

Compaction Temperature

- Suggest applying the higher temperature range for open-graded RAC
  - Based on experience of others, may still be marginally low to provide desired performance
  - Primary problems with low temperature placement of open-graded mixes are raveling and delamination

Time Available for Compaction

- Based on experience of others, may still be marginally low to provide desired performance

Compaction Requirements

- Caltrans will implement compaction requirements for RAC-G mixes in the future
  - Acceptance based on pavement cores
  - Proposed lower limit is 91% of maximum theoretical density (equivalent to maximum 9% in-place air voids)
  - Final requirements adopted may vary from current proposal
- No compaction requirements for open-graded RAC mixes, present or future

Compaction Equipment

- Roller types
  - Static steel wheel rollers
  - Pneumatic-tired rollers – do not use with RAC
  - Vibratory steel wheel rollers – required for breakdown
- Rolling sequence
  - Breakdown – immediately behind paver in vibratory mode
  - Intermediate
  - Finish

Roller Pattern

- Selection of compaction equipment
- Width of paving
- Width of roller(s) – for RAC need enough breakdown rollers to cover placement width
- Number of coverages needed
- Nuclear gauges for relative density
- Cores for correlation of gauges with in-place density, i.e. air voids content
Specifications/SSPs

- Specifications for RAC-G, RAC-O, and RAC-O-HB are in process of being updated and revised.
  - Will be included in pending Section 39 revisions.
- Implementation date not set
  - May phase in by piloting on selected projects
  - Might implement for projects bidding after specific date
- Follow requirements in project special provisions to assure use of appropriate version

Summary of Module 4

- Construction Overview
- Surface Preparation
- Manufacture
- Mix Delivery (Hauling)
- Placement
- Compaction
- Specifications/SSPs

Questions?

The Beginning
Keeping roads good with asphalt paving materials

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