

RAP USE IN PAVEMENT PRESERVATION TREATMENTS

March 2023
Version 1.0

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ABSTRACT

In this guidance document we will detail options for local agencies to utilize reclaimed asphalt pavement (RAP) in pavement preservation treatments.

Pavement preservation is an important component of any road maintenance program and enables transportation agencies to maintain roads at a fraction of the time, cost and public disruption associated with more invasive rehabilitation approaches. Recent advancements have expanded the understanding of pavement preservation techniques allowing the complete

replacement of virgin aggregate with RAP. This guidance document serves as a reference for local agencies interested in increasing their RAP use in pavement preservation treatments to take advantage of the sustainability benefits of RAP while reducing the use of virgin aggregates to promote environmental sustainability.

PROBLEM STATEMENT

Current aggregate use is outpacing available reserves and aggregate used in pavement preservation products must meet strict specifications further limiting suitable aggregate and increasing construction costs.

Aggregate is used by numerous industries and is considered an essential raw building material for everything from concrete to pavement preservation seals. Estimates developed by the California Department of Conservation (CDC) indicate that aggregate reserves in San Diego County may run out as soon as 2030. As much as 30% of the aggregate used in San Diego County is already being imported according to the CDC, which has caused aggregate prices to increase significantly over the past couple of decades. If this trend continues, higher aggregate prices will lead to higher construction costs for numerous industries, including pavement

Key Issues:

- Demand for virgin aggregate is high and reserves in San Diego County may run out as soon as 2030
- Importing virgin aggregate is expensive and leads to higher construction costs
- Materials used in pavement preservation products like slurry seals and microsurfacing must adhere to strict specifications, which further limits suitable aggregate sources

RAP USE IN PAVEMENT PRESERVATION TREATMENTS

preservation. Aggregates used in pavement preservation products must meet strict specifications. Some pavement preservation treatments, such as slurry seals and microsurfacing, also require aggregates that have a compatible particle charge further limiting suitable aggregate

sources. This, along with a significant increase in road maintenance spending, as a result of Senate Bill 1 (2017), and limited development of new local aggregate sources has exacerbated the regional aggregate shortage.

SOLUTION

Utilizing RAP in pavement preservation treatments can produce a consistent high quality product that meets required specifications.

RAP offers a sustainable solution to the regions dwindling aggregate supply. In addition to reducing the impacts from mining virgin aggregate, using RAP decreases the strain on the region's landfills. Utilizing RAP in pavement preservation treatments as a substitute for virgin aggregate has been successful with slurry seal, microsurfacing and chip seal treatments provided that the correct gradations are selected and project

mix designs are modified to account for the additional binder associated with the RAP.

The approach for using RAP differs between chip and slurry seals which is detailed below. While some of the specific considerations for each treatment are identified below, please refer to the specifications in the reference section.

Key Take-aways

- RAP use in pavement preservation treatments has been proven to be cost effective and an environmentally sustainable alternative to virgin aggregate use
- RAP can successfully be incorporated into slurry seal and microsurfacing treatments when Type II aggregate is used, RAP storage best practices are followed, RAP clumping is avoided, and when rolled with a pneumatic tire roller
- RAP incorporation in chip seals has been successful when using medium-fine and medium type chips with few modifications to standard specifications for mix design and application requirements

RAP USE IN PAVEMENT PRESERVATION TREATMENTS

Slurry Seal and Microsurfacing

Use of RAP in slurry seal and microsurfacing treatments has only been successful with Type II aggregates. Type II is the most commonly used aggregate size and has a wide array of uses that includes residential, collector and arterial roads. Type I and Type III aggregate treatments have not been successfully completed with RAP. Avoid specifying these materials until additional research has been completed.

Project mix designs are critical when using RAP. The residual binder in RAP, even though aged, can lead to emulsions that are too rich in asphalt binder if standard Type II emulsion mixes are used. To alleviate this issue, a certified lab must run RAP and mix design tests to identify the optimal binder content for a specific RAP source. Mix designs for RAP slurry and micro-surfacing will typically require a 10% to 20% reduction in emulsion content, an increase in the overall residual asphalt from 7.5% to 12.5% minimum. The binder requires a polymer modification of at least 3% by weight of asphalt, an increase compared to conventional slurry seals but consistent

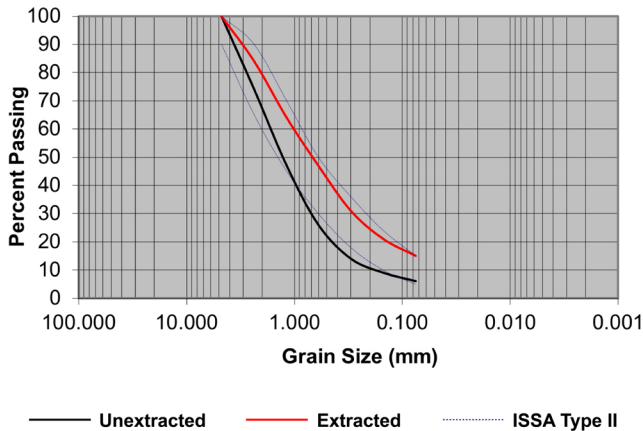
with conventional microsurfacing standards. The additional polymer modification is to assist the early retention of RAP at the lower binder content. Once early retention is achieved, the residual asphalt in the RAP and binder develop a strong adhesion with time, temperature and traffic exposure.

RAP sources must be closely managed by the supplier to maintain consistent gradation and residual asphalt content. During storage, RAP can bind into clumps, especially in hot weather, under high compression in large stockpiles or when sitting too long (as little as two to three weeks) requiring additional processing or screening. Turning RAP stockpiles weekly and utilizing multiple stockpile sides will also help prevent clumping. While additional stockpile management is necessary, using RAP aggregate typically alleviates the concern for charge compatibility between the emulsion and aggregate because aging and residual asphalt diminishes any charge in the RAP aggregate.



RAP USE IN PAVEMENT PRESERVATION TREATMENTS

Gradation Curve Comparison

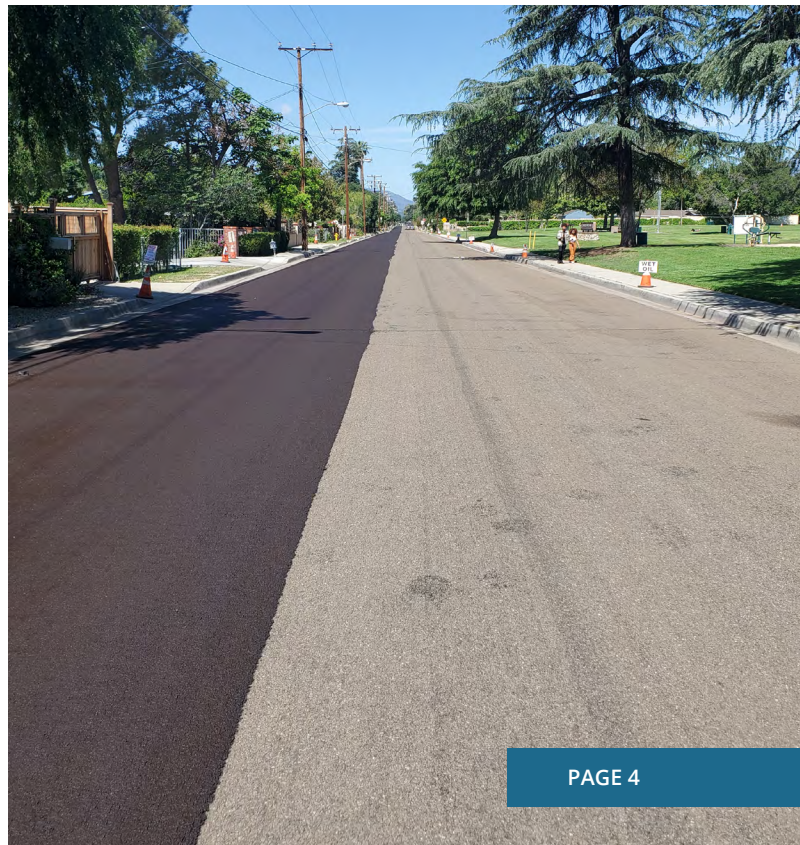


The residual asphalt coating on RAP increases the particle size of the original crushed stone causing it to fall outside the standard Type II limit as identified on the graph. This requires a slight modification to the standard Type II aggregate specification when using RAP.

Slurry seal and microsurfacing application processes change very little when using RAP aggregate, but there are important processes to follow to ensure a high-quality product. Equipment should not be loaded the day before application if ambient temperatures are forecasted to be over 95 degrees Fahrenheit. Additionally, the spreading machine hopper should be cleaned regularly to avoid RAP clumping and to remove RAP buildup. Following the application of a RAP seal treatment, always roll the new surface with a pneumatic tire roller. A minimum of three complete passes is necessary prior

to opening to traffic which will lead to higher aggregate retention and a smoother surface.

Utilizing RAP in slurry seal and microsurfacing treatments can provide a number of benefits beyond those associated with recycling and environmental sustainability. Most RAP aggregates carry a neutral charge making it compatible with seal treatments. The inclusion of RAP and the higher residual asphalt content lead to a deep black surface that is maintained longer than standard seal treatments and provides superior traffic delineation. RAP also supports greater aggregate retention and continued rolling under traffic provides a smooth uniform surface.



RAP USE IN PAVEMENT PRESERVATION TREATMENTS

Chip Seal

Utilizing RAP in chip seal applications has been successful with medium fine (5/16") and medium (3/8") type chips. Unlike RAP slurry seals, standard specifications for RAP chip seals do not need to be modified. The binding quality of RAP chips is very high due to the residual asphalt present.

RAP chips can be used with all emulsion binders and as a replacement for hot, precoated chips when applied with modified asphalt binder. When used with hot applied asphalt binder the RAP chips do not need to be heated

but must be completely dry to ensure proper adhesion. Use caution when utilizing a rejuvenating emulsion with RAP chips to avoid over application of binder. Multilayer seals are not recommended when using 100% RAP chips as the residual binder in RAP can lead to a product that is too rich in asphalt binder and can cause bleeding. However, mixing RAP with virgin aggregates can produce a high quality multi-layer seal treatment. As with slurry seals and microsurfacing treatments, RAP chips support greater early aggregate retention and provide a superior surface finish.



RAP USE IN PAVEMENT PRESERVATION TREATMENTS

CONCLUSION

Use of RAP in pavement preservation treatments offers several environmental benefits including reduced impact to virgin aggregate sources, reduced greenhouse gas emissions from mining and hauling operations and decreased strain on the regions landfills. In addition, widespread RAP use offers an economic benefit from the reduction of fuel use and disposal fees.

The benefits of utilizing RAP in pavement preservation treatments extend beyond environmental sustainability and cost savings. RAP use offers performance benefits compared to conventional seal treatments including higher early aggregate retention, increased compatibility

with catatonic emulsions, and a deeper black color which allows for superior pavement delin-eation. These benefits can typically be realized with only minor modifications in specifications and implementation of RAP best management practices.

REFERENCES

- County of San Diego (Attached)
- Source: The California Department of Conservation



**COUNTY OF SAN DIEGO
DEPARTMENT OF PUBLIC WORKS**

RAP PAVEMENT SEAL SPECIFICATIONS

THESE SPECIFICATIONS ARE INTENDED TO BE USED IN CONJUNCTION WITH THE 2015 CALTRANS STANDARD SPECIFICATIONS AND THE LATEST REVISIONS TO THE 2015 STANDARD SPECIFICATIONS DATED 4/20/2018

37 BITUMINOUS SEALS

Replace *Department's Independent Assurance Program* in the 1st paragraph of section 37-1.01D(1) of the RSS with:

CALTRANS Independent Assurance Program.

Replace 2nd paragraph of section 37-1.01D(1) with:

For emulsion testing, quality control laboratories must be AASHTO accredited laboratories and participated in the AASHTO re:source proficiency sample program.

Add to the end of section 37-1.03A:

No part of the project will change any grades or divert runoff in any way.

Add to the list in the 1st paragraph of section 37-2.01A(3):

6. RAP test results for the following:
 - 6.1. Gradation
 - 6.2. Sand Equivalent

Replace "Reserved" in section 37-2.01A(4)(b)(i) with:

Provide a Chip Seal Operations Manager with sufficient knowledge and experience (3 similar sized projects within the last 2 years) in chip seal operations. The Chip Seal Operations Manager shall be onsite for all chip seal work and shall provide input on the emulsion formulation and application rates as described elsewhere in this specification. Submit proof of experience within 10 working days of receipt of the Notice to Proceed.

Provide an independent authorized laboratory. The independent authorized laboratory must be accredited under Caltrans' Independent Assurance Program and participate in the AASHTO Proficiency Sample Program. Submit the independent authorized laboratory qualifications to the Engineer for approval within 10 days of the Notice to Proceed.

At least 10 days prior to seal work commencing, provide the following certifications and testing results from the independent authorized laboratory:

1. Certification from the emulsion manufacturer stating that the polymer modified asphaltic emulsion meets the specifications along with testing results from an independent authorized laboratory.
2. Certification from the screenings supplier stating that the screenings meet the specifications along with testing results from an independent authorized laboratory.

At least 10 days prior to starting the seal work, submit the following samples to the Engineer. Sample sizes must conform to the type and size indicated below and must include corresponding SDS/MSDS sheets. Each sample must be clearly labeled as to its contents, project name, job number and supplier name.

1. 1/2 gallon of polymer modified asphaltic emulsion in a clean airtight container.
2. 10 pounds of screenings.

10 days prior to beginning chip seal work, submit proof of distributor truck calibration conforming to CT 109.

During the work, provide Certificates of Compliance for each shipment of polymer modified asphaltic emulsion. Polymer modified asphaltic emulsion shipped without a Certificate of Compliance will not be allowed to be used on the work unless otherwise approved by the Engineer. County is not responsible for any delays associated with obtaining the approval of the Engineer.

Submit quality control testing reports as described herein.

Add to the table of section 37-2.01A(3):

Sand Equivalent (min, only for RAP)	24 hours
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Add to the end of section 37-2.01A(4)(b)(ii):

If RAP is used, RAP screening shall be produced by crushing asphalt concrete pavement, free of detrimental quantities of deleterious materials. RAP quality requirements shown in the following table:

RAP Quality Control

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Sand equivalent (min)	California Test 217	1 per working stockpile per day	See California Test 125
Gradation (% passing by weight)	California Test 202	2 per working stockpile per day	See California Test 125

Add to the end of section 37-2.01A(4)(c):

If RAP is used, for RAP, acceptance is based on the County's sampling and testing for compliance with the requirements shown in the following table:

Chip Seal RAP Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirements
Sand equivalent (min)	California Test 217	80
Gradation (% passing by weight)	California Test 202	Aggregate Gradation table shown under Materials for the chip seal type specified.

Add to the end of section 37-2.01B(3)(a):

If RAP is used, RAP must comply with the requirements shown in the following table:

Chip Seal RAP Requirements

Quality characteristic	Test method	Requirements
Sand equivalent (min)	California Test 217	80
Gradation (% passing by weight)	California Test 202	Aggregate Gradation table shown under Materials for the chip seal type specified.

Add the following to the list in section 37-2.01C(2):

4.6. Be 5-ton.

Add the following after the 2nd paragraph of section 37-2.03B(2) :

For RAP chip seals, A polymer modified asphaltic emulsion must be Grade PMCRS2h.

Add to the end of section 37-2.03B(3):

For RAP chip seals The size of screenings used shall be medium fine (M-F, 5/16”) or medium (Med, 3/8”) as shown in the contract documents.

Replace section 37-2.03C with:

37-2.03C Construction

37-2.03C(1) General

Reserved.

37-2.03C(2) Applying Polymer Modified Asphaltic Emulsion

Polymer modified asphaltic emulsions must be applied within the application rate ranges shown in the following table:

Polymer Modified Asphaltic Emulsion Application Rates

Aggregate Size, Aggregate gradation	Application Rate Range (gal/sq yd)	Initial Application Rate (gal/sq yd)
Medium, 3/8”	0.30–0.45	0.38
Medium-Fine, 5/16”	0.25–0.35	0.32

For double polymer modified asphaltic emulsion chip seals, polymer modified asphaltic emulsions must be applied within the application rates shown in the following tables:

Polymer Modified Asphaltic Emulsion Application Rates (Virgin Aggregates+ Virgin Aggregates)

Double Application, Aggregate Size	Application Rate Range (gal/sq yd)	Initial Application Rate (gal/sq yd)
1st application, medium (Virgin)	0.30–0.45	0.32
2nd application, medium-fine (Virgin)	0.20–0.30	0.25

Polymer Modified Asphaltic Emulsion Application Rates (Virgin Aggregates+ RAP)

Double Application, Aggregate Size	Application Rate Range (gal/sq yd)	Initial Application Rate (gal/sq yd)
1st application, medium (Virgin)	0.30–0.40	0.32
2nd application, medium-fine (RAP)	0.18–0.25	0.20

Polymer Modified Asphaltic Emulsion Application Rates (RAP+ RAP)

Double Application, Aggregate Size	Application Rate Range (gal/sq yd)	Initial Application Rate (gal/sq yd)
1st application, medium (RAP)	0.30–0.40	0.32
2nd application, medium-fine (RAP)	0.18–0.25	0.20

Use the initial application rate for each road. Provide in writing any adjustments to the initial application rate. The Engineer must authorize the adjusted rates before application.

Apply polymer modified asphaltic emulsions when the ambient air temperature is from 60 to 105 degrees F and the pavement surface temperature is at least 80 degrees F.

Do not apply polymer modified asphaltic emulsions when weather forecasts predict the ambient air temperature will fall below 39 degrees F within 24 hours after application.

Do not apply emulsion at a greater distance than can be immediately covered by aggregates/screenings, and, in no case, shall the distributor truck advance more than 200 feet ahead of the screening spreader.

37-2.03C(3) Spreading Screenings

Spreading Screenings must conform to Section 37-2.01C(4)(c).

Screening for both virgin aggregate and RAP must be spread within the spread rate ranges shown in the following table:

Screening Spread Rates		
Screening Size, Screening gradation	Application Rate Range (lb/sq yd)	Initial Application Rate (lb/sq yd)
Medium, 3/8"	20–30	27
Medium-Fine, 5/16"	16–25	24

For double chip seals, virgin aggregates or RAP must be spread within spread rate ranges shown in the following table:

Screening Spread Rates		
Double Application, Screening Size	Application Rate Range (lb/sq yd)	Initial Application Rate (lb/sq yd)
1st application, medium	23–30	27
2nd application, medium-fine	12–20	18

Use the initial application rate for each road. Provide in writing for adjustments to the initial spread rate. The Engineer must authorize the adjusted rates before application.

Remove excess aggregate on the 1st application before the 2nd application of asphaltic emulsion.

You may stockpile aggregate for the polymer modified asphaltic emulsion chip seals if you prevent contamination. Aggregate must have damp surfaces at spreading. If water visibly separates from the aggregate, do not spread. You may redampen aggregate in the delivery vehicle.

Spread aggregate before the polymer modified asphaltic emulsion sets or breaks.

Do not spread aggregate more than 2,500 feet ahead of the completed initial rolling.

37-2.03C(4) Flush Coat

Flush Coat must conform to Section 37-4.03.

Apply a flush coat on roads that are scheduled for chip seal (single and double chip seal).

Asphaltic emulsion for the flush coat must be grade CQS1h per Section 94-1.02E.

37-2.03C(5) Finishing

37-2.03C(5)(a) General

Finishing must comply with section 37-2.01C(4)(d).

Perform the following work prior to placement of the second application of chip seal on roads scheduled for double chip seal:

1. Initial rolling
2. Final rolling
3. Removal of excess screenings

37-2.03C(4)(e)(ii) Sweeping

Sweeping must be performed after the chip seal has set and there is no damage or dislodging of screening from the chip seal surface. As a minimum, sweeping is required at the following times:

1. On 2-lane 2-way roadways, from 2 to 4 hours after traffic, controlled with pilot cars, has been routed on the chip seal
2. On multilane roadways, from 2 to 4 hours after aggregate have been placed
3. In addition to previous sweeping, perform final sweeping immediately before opening any lane to public traffic, not controlled with pilot cars

Comply with the following sweeping schedule:

1. Day 1:
Pre-Application Sweeping:
Sweep the road on the same day and immediately prior to commencing chip seal operations on a specific road.

Post-Application Sweeping:
Sweep the road on the same day as chip seal was performed and prior to applying flush coat (if called for) and opening a road to public traffic. Back-pack style blowers must be used to ensure screenings are removed from driveways, gutters, sidewalks, and all other areas where loose screenings are present.
2. Day 2 - 4:
Perform post application sweeping as described for Day 1.

No sweeping is required on weekends.

The Engineer will order additional sweeping as required. The County does not pay for this additional work.

Assume full liability and pay all costs associated with any claims made for cracked/broken windshields, damage to paint, etc. on roads scheduled for chip seal at no cost to the County.

Include the sweeping schedule on all notices provided to the public.

The County may assess liquidated damages in the amount of \$2,500.00 per day for each day the sweeping schedule described herein is not adhered to; the work must be performed by your own forces or an outside contractor. The Engineer will determine the cost of said work and deduct from remaining monies owed to you.

Add to the end of section 37-3.01C(5)(d):

Before opening to traffic, perform rolling consisting of 3 coverages with a pneumatic-tired roller per 37-2.01C(2).

Replace Section 37-3.04 with:

37-3.04 POLYMER MODIFIED RECLAIMED ASPHALT PAVEMENT (PM-RAP) SLURRY SEAL SURFACING

37-3.04A General

37-3.02A(1) Summary

Section 37-3.04 includes specifications for applying PM-RAP slurry seals.

37-3.04A(2) Definitions

Reserved

37-3.04A(3) Submittals

Submit a licensed weighmaster certificate for each delivery of RAP aggregate to the job site.

Submit a licensed weighmaster certificate and certificate of compliance with each delivery of polymer modified asphaltic emulsion to the job site.

37-3.04A(4) Quality Assurance

37-3.04A(4)(a) General

Reserved

37-3.04A(4)(b) Quality Control

37-3.04A(4)(b)(i) General

Take samples of polymer modified asphaltic emulsion from the tank truck at mid load or from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer take two 1-quart samples in wide mouth plastic containers with lined, sealed lids for acceptance testing.

During the performance of the Work, test the quality of work by taking at least 2 field samples of the mixed slurry per slurry mixer per Day. The Wet Track Abrasion Test sample shall not be transported until the slurry has set as defined by ASTM D391.

You shall perform "referee" sampling. No changes in machine calibration will be allowed between sampling. The County will observe the referee sampling to ensure compliance with specified procedures. The County shall be given the opportunity to observe the remaining portions of the WTAT to assure the accuracy of the referee test. Notify the Engineer at least 24 hours in advance of actual test performance. The referee WTAT shall be performed by an independent, certified laboratory. The results of each referee test will be compared to the respective test performed by the County. At the discretion of the Engineer, the referee test may be used as a basis to modify the result of the respective test performed by the County.

If the test results fail to meet the Specifications, cease spreading slurry seal produced by the nonconforming mixer until you demonstrate the mixer is producing slurry seal which conforms to the Specifications.

37-3.04A(4)(b)(ii) RAP

For RAP, the authorized laboratory must perform quality control sampling and testing at the specified frequency for the following quality characteristics:

RAP

Quality characteristic	Test method	Minimum sampling and testing frequency
Gradation of Un-Extracted RAP	ASTM C136	1 per working stockpile per day
Sand Equivalent	ASTM D2419	
Asphalt Binder Content	AASHTO D 2172 (Method B)	1 per 1000 tons of processed RAP
Asphalt Binder Performance Grade	AASHTO M 323	

Test the resulting asphalt binder and solvent resulting from AASHTO D 2172 per AASHTO T 319 or ASTM D1856

37-3.04A(4)(b)(iii) Polymer Modified Asphaltic Emulsion

For polymer modified asphaltic emulsions, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Polymer Modified Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling Location
Tests on emulsion:			
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Delivery truck
Sieve test (%)	AASHTO T 59		
Storage stability after 1 day (%)	AASHTO T 59		
Residue by evaporation (min, %)	California Test 331		
Particle charge	AASHTO T 59		
Tests on residue by evaporation:			
Penetration at 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Delivery truck
Ductility at 25 °C (min, mm)	AASHTO T 51		
Torsional recovery (min, %)	California Test 332		
Or Polymer content based on residual asphalt (min, %)	California Test 401		

37-3.04A(4)(b)(iv) PM-RAP Slurry Seal

For PM-RAP Slurry Seal, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

PM-RAP Slurry Seal

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling Location
Wet Track Abrasion Test, Weight Loss, gm/ft ² (gm/m ²) Type Fine Aggregate	ASTM D3910 ^a	Minimum 2 per day	Spreader
Consistency Test (mm)	ASTM D3910 ^a	Minimum 2 per day	Spreader
Extraction Test (Calculated Emulsion Content, %)	D6307 ^b , CT 382 ^b	Minimum 2 per day	Spreader
Water Content (% of Dry RAP Aggregate Weight)	See Note ^c	Minimum 2 per day	Spreader

^a Modified ASTM D3910 to include No. 4 (4.75 mm) aggregate or greater and to be performed using field samples. Subsection 6.4.4.7, ASTM D 3910 may be modified to use a microwave oven for drying the specimen after the abrasion cycle is complete and the debris washed off.

^b Modified ASTM D6307 and California Test Method 382 to allow a minimum of 500 ± 50 grams sample.

^c Weigh a minimum of 500 grams of homogenized mixed slurry into a previously tared quart can with a friction lid. The lid shall be placed on the can to prevent loss of material during transportation. Place the can with the lid off in an oven and dry to constant mass at 220°F ± 10°F (110° C ± 5°C).

ASTM D3910 shall be used on field samples during performance of the Work. ASTM D3910 is modified as follows:

1. Wet Cohesion test results are not required as part of the mix design submittal.
2. “set time” test is not required with slow set emulsion.

37-3.04A(4)(c) Department Acceptance

Acceptance is based on the Department’s sampling and testing for compliance with the requirements for the quality characteristics specified.

RAP acceptance is based on the Department’s sampling and testing for compliance with the requirements shown in the following table:

RAP-Acceptance Criteria		
Quality characteristic	Test method	Requirements
Gradation of Un-Extracted RAP	ASTM C136	Aggregate Gradation table shown in this section.
Sand Equivalent	ASTM D2419	60 Minimum

Slurry acceptance is based on the Department’s sampling and testing for compliance with the requirements shown in the following table:

PM-RAP Slurry Seal Acceptance Criteria

Quality characteristic	Test method	Requirements
Wet Track Abrasion Test, Weight Loss, gm/ft ² (gm/m ²) Type Fine Aggregate	ASTM D3910 ^a	0-50(540)
Consistency Test (mm)	ASTM D3910 ^a	30
Extraction Test (Calculated Emulsion Content, %)	D6307 ^b , CT 382 ^b	± 1 % of mix design
Water Content (% of Dry RAP Aggregate Weight)	See Note ^c	< 25

^a Modified ASTM D3910 to include No. 4 (4.75 mm) aggregate or greater and to be performed using field samples. Subsection 6.4.4.7, ASTM D 3910 may be modified to use a microwave oven for drying the specimen after the abrasion cycle is complete and the debris washed off.

^b Modified ASTM D6307 and California Test Method 382 to allow a minimum of 500 ± 50 grams sample.

^c Weigh a minimum of 500 grams of homogenized mixed slurry into a previously tared quart can with a friction lid. The lid shall be placed on the can to prevent loss of material during transportation. Place the can with the lid off in an oven and dry to constant mass at 220°F ± 10°F (110° C ± 5°C).

ASTM D3910 shall be used on field samples during performance of the Work. ASTM D3910 is modified as follows:

3. Wet Cohesion test results are not required as part of the mix design submittal.
4. "set time" test is not required with slow set emulsion.

37-3.04B Materials

37-3.04B(1) General

Reserved

37-3.04B(2) Polymer Modified Asphaltic Emulsions

Polymer Modified Asphaltic Emulsion shall be grade PMCQS-1h. The percentage of emulsified asphalt and residual asphalt content shall conform to the requirements shown in the following table:

Emulsified Asphalt and Residual Asphalt Content		
Tests	Test method	Requirements
Emulsified Asphalt, % by weight of dry RAP Aggregate	-	9.0-14.0
Residual Asphalt Content, % by weight of dry RAP Aggregate	ASTM D6307 ^a Or CTM 382 ^a	11.0 Min

^aSample size shall be 500g minimum.

37-3.04B(3) RAP

Stockpiles of processed RAP shall be uniformly layered and constructed on a base which provides drainage. RAP stockpiles shall be kept clean and free from contaminants. RAP aggregate shall conform to the requirements in the following table:

RAP Aggregate Quality

Tests	Test method	Requirements
Percentage Wear, 500 Revolutions ^a	ASTM C131	35% Maximum
Sand Equivalent	ASTM D2419	60 Minimum
Soundness (5 Cycles) ^a	ASTM C88	15% Maximum
Durability	CTM 229	55 Minimum

^aOn RAP retained on No. 4 sieve.

37-3.04B(3)(i) Grading

The grading of the combined RAP aggregates shall conform to the requirements shown in the following table:

Gradation		
Requirements	Un-Extracted RAP-% OF Combined Aggregate Passing Sieves (ASTM C136)	Extracted RAP-% OF Combined Aggregate Passing Sieves (ASTM C136)
3/8" (9.5 mm)	100	100
No. 4 (4.74 mm)	90 - 100	90 - 100
No. 8 (2.36 mm)	60 - 90	65 - 90
No. 16 (1.18 mm)	35 - 60	45 - 70
No. 30 (600 µm)	23 - 45	30 - 50
No. 50 (300 µm)	12 - 30	18 - 36
No. 100 (150 µm)	5 - 20	10 - 24
No. 200 (75 µm)	0.5 - 10	5 - 15

37-3.04B(4) PM-RAP Slurry Seal Mix Design

Mix designs shall conform to ASTM D 3910.

The laboratory report submitted must include:

1. Aggregate Source and Supplier
2. Emulsified Asphalt Supplier
3. Test results, except for cohesion test

37-3.04B(5) Set Control Agents

Set control agents shall be one of the following:

1. Type II or Type V Portland cement
2. Aluminum sulfate
3. Other material approved by the Engineer

37-3.04B(6) Water

Water shall be potable and compatible with the other ingredients of the slurry.

37-3.04C Construction

37-3.04C(1) General

Furnish, operate, maintain, and remove portable scales at the stockpile site. Scales shall be calibrated, certified, and sealed after installation and prior to initial use by a State of California Department of Food and Agriculture, Division of Measurement Standards, Registered Service Agency. A listing of registered service agencies is available at the following:

<https://www.cdffa.ca.gov/dms/programs/ras/rsalistings/rasListings.html>

37-3.04C(2) Mixing and Spreading Equipment

PM-RAP slurry seal shall be mixed in continuous-flow mixers.

Prior to the beginning of slurry operations, furnish current licensed weighmaster's certificates indicating the net weight capacity of the aggregate bin of each mixer. Except for partial loads to complete a day's schedule, or for patching, each mixer shall be filled to its rated capacity and You and the Engineer shall each keep a daily count of the number of loads and/or partial loads applied to the surface of the existing pavement by each mixer. Each aggregate bin shall have permanent calibration marks in maximum increments of 2 tons.

2 fully operational mixers for use at the Work site are required at all times. These mixers shall be available for inspection by the Engineer at least 48 hours prior to commencing the Work.

37-3.04C(3) Placement

PM-RAP Slurry Seal shall be applied at a rate of 10 to 15 pounds of dry RAP aggregate per square yard over existing or micro-milled pavement and at a rate of a minimum of 19 pounds of dry RAP aggregate per square yard over chip seals. The exact rate shall be as directed or approved by the Engineer.

When the Engineer determines that the application rate does not conform to the requirements, take immediate corrective action. When the rate is less than the minimum amount required, reapply additional PM-RAP slurry seal material to the nonconforming area to meet the requirements.

37-3.04D Payment

The payment quantity for PM-RAP slurry seal is the weight determined by combining the weights of the RAP aggregate and polymeric asphaltic emulsion. The payment quantity for slurry seal does not include the weights of the added water and set-control additives.

37-3.04D(1) Payment Reduction

If the average of all Wet Track Abrasion Tests made per slurry mixer per day by the Engineer fail to conform to the requirements specified in this section, you agree that payments for the work represented by the failed tests shall be reduced as shown in the following table:

WTAT Loss gm/ft ² (gm/m ²)	Payment Reduction (Percent)
0 – 50 (0 – 540)	0
50.1 – 60 (540.1 – 650)	5
60.1 – 70 (650.1 – 750)	15
70.1 – 80 (750.1 – 860)	30
80.1 – 99 (860.1 – 1070)	70
99.1 or greater (1070.1 or greater ^a)	100

^a Slurry seal surfacing with WTAT loss greater than 99.1 gm/m² (1070.1 gm/ft²) shall be removed to the satisfaction of the Engineer.