Evaluation of City of Woodland Cape Seal Project Placed in 2009

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PROJECT SUMMARY PAGE	Tech Report: 2011-110
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Abstract: This report describes the results of an independent assessment of a cape seal test project placed in the City of Woodland in 2009. Two different polymer modified rejuvenating chip seals were placed in the spring of 2009 followed by the application of a micro-surfacing. The products were placed with and without a fabric layer underneath the cape seal on a badly distressed pavement. The City monitored the performance over the next few years noting cracking in some of the test sections.

In November 2011, the CP^{2}Center evaluated the section and arranged for cores to be taken of each of the 4 test sections. The findings of the pavement survey indicated a clear difference in performance between the 2 products. The sections with the fabric did not perform any better than those without fabrics.

The cores were tested for asphalt properties, permeability and in the Asphalt Pavement Analyzer (APA) for resistance to loaded wheel tracking. The tests on the cores showed that the PMRE did not soften the underlying pavement for either of the products. The permeability showed that PASS product sections had lower permeability than Stryaflex test sections. The resistance to cracking for each of the products based on the APA testing results showed that PASS test sections should perform better than the Styraflex test sections. The paving fabric used for the test sections didn't affect the fatigue life significantly.

Keywords:

PMRE, Cape Seals, Scrub Seal, Micro-surfacing, permeability, asphalt properties, reflection cracking

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Disclaimer

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The content does not necessarily reflect the official views or policies of the City of Woodland.

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1.0 Introduction

1.1 Background

When an existing pavement is aged and cracked, one strategy that can be used to preserve the pavement is called a scrub seal. A scrub seal is a process by which modified emulsions are applied and then are scrubbed or squeezed into the existing cracks. A layer of chips is then applied to form a new wearing surface. When the existing pavement is very old and oxidized, a rejuvenating agent is added to form a polymer modified rejuvenating emulsion (PRME) to restore the properties of existing binders. The surface of a scrub seal is rough similar to a chip seal. Therefore, a slurry or micro-surfacing is normally applied to the top of the scrub seal to provide a smoother surface for use on City streets.

To understand the performance of the different rejuvenating scrub seal products, the City placed a side by side comparison of two rejuvenation seals in 2009 on Woodland Avenue between N. College Street and Freeman Street shown in Figure 1.

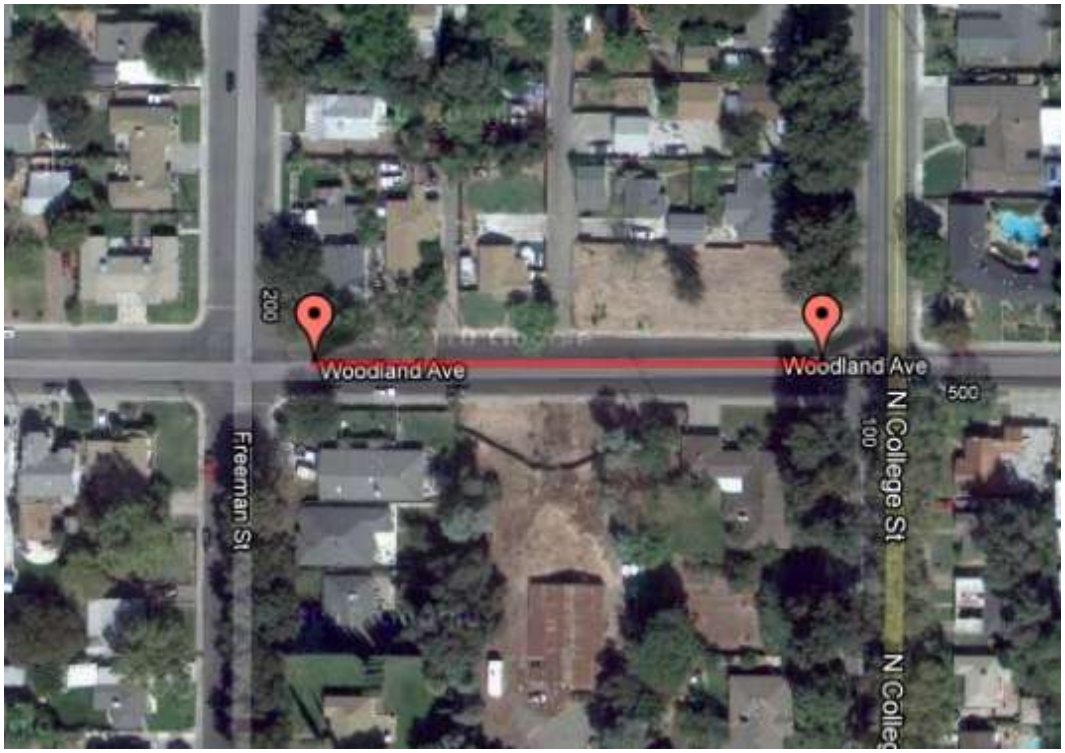


Figure 1. The test section located in the City of Woodland, CA

The test strip was first constructed with Rejuvenating Scrub Seal or a Rejuvenation Scrub Seal over fabric followed by a micro-surfacing to form the Cape Seal. For each of the treatments, two products were used as follows:

- PASS CR (Product A) produced by Western Emulsions
- Styraflex ERA (Product B) produced by VSS Emultech

PASS is a polymer modified rejuvenating emulsion for treating aged and cracked pavements. It was designed to bring the consistency of asphalt in a cracked pavement back to the point that it will resist cracking and to glue cracked pieces of pavement back together. Crack filling prior to a chip seal or thin HMA overlay project is a very time consuming and labor-intensive activity. Using PASS CR in a scrub seal system serves the purpose of both chip seal wearing course and rapid crack fill solution in one single application. Styraflex is a binder emulsion that penetrates the surface and replenishes the lost oils in the existing aged binder. The polymer and asphalt emulsion creates a tough binder to hold onto the chips. The polymers used in the two products are different.

A micro-surfacing was applied on the rejuvenating scrub seal to form two different treatments: rejuvenating cape seal and rejuvenating cape seal with paving fabric. For each treatment type, there were two different materials used: Product A (PASS CR) and Product B (Styraflex). Both scrub seals should meet the specifications in Appendix A. Micro-surfacing should meet the specification in Appendix B and the paving fabric should meet the specification in Appendix C.

1.2 Project Objective

The purpose of this study is to conduct an independent analysis of the treatments and the products to determine which of the products is performing best in each of the treatment types. At the time of the evaluations, the location of the various products within the test sections was not known. Once the pavement assessment was completed and documented, the City revealed the locations of the various products used in the study.

1.3 Project Scope

The contents of the report are organized as follows:

- Chapter 2 discusses the preconstruction pavement condition. This information was provided by the City.
- Chapter 3 describes the construction information. This information was provided by the City.
- Chapter 4 discusses the post-construction visual inspection. This was accomplished in November 2011 by Center staff.
- Chapter 5 presents the materials testing results during 2011. The tests on the recovered binder were provided by APART while the permeability and APA tests were performed by the CP2 Center.
- Chapter 6 contains the conclusions and recommendations of the authors.

2.0 Pre-Construction Data

Woodland Ave, between Freeman and N. College, is classified as local road whose primary purpose is to provide access to higher functional collector roads. This section of the report provides information on the traffic and pavement condition before the Cape Seal was applied in the spring of 2009.

2.1 Traffic Loading

Based on the City's traffic study in 2007, this portion of road has an Average Daily Traffic volume of 1197 vehicles/day. The traffic index, TI, is 6.0 and there is 2% truck traffic.

2.2 Existing Pavement Condition Survey

The City of Woodland did a pavement condition rating in 2008 and rated this segment of Woodland Avenue in poor to very poor condition. There were areas that had extensive alligator cracking while most of the existing surfacing had minor to moderate cracking. Figure 2 shows pavement has severe alligator cracking. Figures 3 and 4 show some areas had skin patching. Figure 5 illustrates closer look of existing pavement conditions.

Figure 2. Pre-Construction pavement had severe level of alligator cracking

Figure 3. Pre-Construction pavement condition with some skin patching

Figure 4. Pre-Construction alligator cracking with patching - Cracks were wide and active

Figure 5. Pre-Construction - Closer look at cracks within the test strip area

As can be seen in the photos, the pavement was in poor condition and probably should have required something more than a Cape Seal. If enough information were given, it would be valuable to create a map showing the type and extent of distress within each of the test sections.

3.0 Construction Data

The test strip was constructed in the spring of 2009 by two different contractors. It consisted of four separate test sections as shown in Table 1. The sections were about 150 foot long and were placed on half of the street from curb to centerline as shown in Figure 6.

Table 1. Test sections for the Woodland Ave test strip

Section Number	Treatment Type	Emulsion	Paving Fabric
1	Scrub cape seal over fabric	Product A: PASS CR	Yes
2	Scrub cape seal over fabric	Product B: Styraflex	Yes
3	Scrub cape seal	Product A: PASS CR	No
4	Scrub cape seal	Product B: Styraflex	No

Paving fabric and scrub seals were placed on the same day and they were allowed to remain in situ for at least 3 days before first sweeping. The City of Woodland prefers this to allow more chips to be worked into the material from the rubber tire traffic. Also, the residents in the City are used to chips in the road for up to a week due to the City's long history of sand seals. The City gets very few complaints and has had no broken windshield claims for years. There was a minimum of 7 days and 2 sweepings after the chip was placed before the micro-surfacing was placed. The City of Woodland used 08-67 special provisions for the Styraflex application and 07-44 seal coat specs for the PASS application (see Appendix for these items).

All sections received a subsequent treatment of Type 2 micro-surfacing. Sections 1 and 3 were constructed by Intermountain Slurry, Inc. in March/April 2009 while sections 2 and 4 were constructed by Valley Slurry Seal in May 2009. On all sections, a microsurfacing seal was placed as a final treatment.

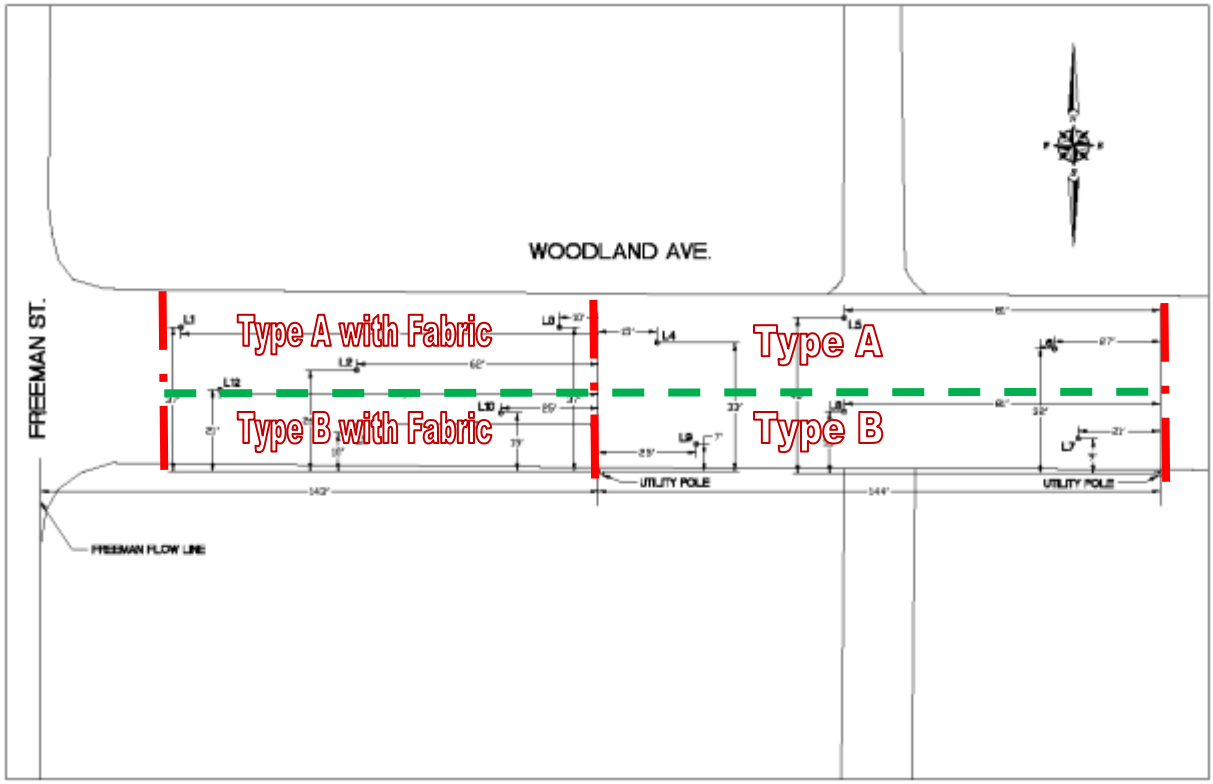


Figure 6. The schematic layout of the four different test sections on Woodland Ave.

4.0 Post Construction Pavement Condition Survey

The project was visited multiple times by the City staff as well as other parties. The following section describes the pavement condition at various times. The Center visited the site on November 10, 2011.

4.1 City Observations

Assistant engineer, Tami Burnham, inspected the construction site multiple times to photograph and document the surface condition. The Figure 7 shows that the product B (Styraflex) started to show micro cracks 1-2 months after placement.

Figure 7. Micro cracks started to show up in product B after 1-2 months of placement

During the fall of 2009, there was no apparent cracking on the north side which contained Product A (PASS CR). There were some micro cracks on the south side where Product B (Styraflex) was used.

In fall 2010, there was significant visible cracking on south side section and some minor cracking beginning to appear on the north side section.

4.2 Field Visit by CP2 Center during Fall 2011

On November 10, 2011, CP2 Center conducted a blind independent field pavement condition survey of the test sections. The location of the products was not given to the inspection team until after the survey was completed.

Based on the survey, the pavement exhibited cracking throughout the sections. Some sections exhibited more cracking than others. However, the cracks were much smaller compared with the adjacent of Woodland without treatments. Figure 8 shows the difference in cracks between untreated adjacent pavement and treated pavement. The Styraflex sections exhibited a blacker color than the PASS sections. However, PASS sections had less cracks and performed better than the Styraflex sections. The sections with the paving fabric didn't have better performance than the scrub seal sections for either the PASS or Styraflex PMRE products. There was no rutting in any of the test sections.

a. Untreated pavement cracks

b. Styraflex Fabric Cape seal treated pavement cracks

Figure 8. Adjacent pavement cracks versus cape seal cracks

4.2.1 Section 1: PASS with Fabric Observation

There were a total of 12 cores taken from various pavement test sections. The cores were taken for the City by their consultant. Cores 1 to 3 are from the section containing the PASS scrub seal over the paving fabric. Figure 9a to 9c show the pavement conditions around the cores. Photos are taken from west to east. Figure 9d shows the cracking in this section.

a. Pavement condition around core #1

b. Pavement condition around core #2

c. Pavement condition around core #3

d. Cracks in section 1

Figure 9. Pavement conditions for section 1 PASS with fabric

4.2.2 Section 2: Styraflex with Fabric Observation

Cores 10 to 12 are from the section containing the product Styraflex over paving fabric. Figure 10 shows the pavement condition around the cores.

Figure 10. Pavement conditions around cores in Section 2

Figure 11 shows the darker color of Section 2 (Styraflex) versus Section 1(PASS). Figure 12 shows a close-up of the cracking in this section.

Figure 11. The left of the picture is the Styraflex over fabric

Figure 12. Cracks in the Styraflex with fabric section

4.2.3 Section 3: PASS Scrub Cape Seal

Figure 13 shows the pavement condition around the cores #4 to #6, which represented the PASS scrub cape seal without fabric. Figure 13d shows some of the cracking in this section: however, when water was poured onto the crack, it didn't penetrate the crack into underlying materials.

a. pavement condition around core #4

b. pavement condition around core #5

c. pavement condition around core #6

d. water couldn't penetrate the crack

Figure 13. Pavement conditions for section 3

Figure 14 shows the uneven surface of the cape seal, which may be caused by underneath cracks. As noted, the cracks didn't reflect up through the PASS Cape seal which illustrates its crack resisting capabilities.

Figure 14. Crack didn't reflect through the cape seal

4.2.4 Section 4: Styraflex Cape Seal

Figure 15 shows the pavement conditions around cores #7 to #8 while Figure 16 shows the typical crack pattern in this section. There are more cracks in this section than in section 3.

Figure 15. Pavement condition around cores in section 4

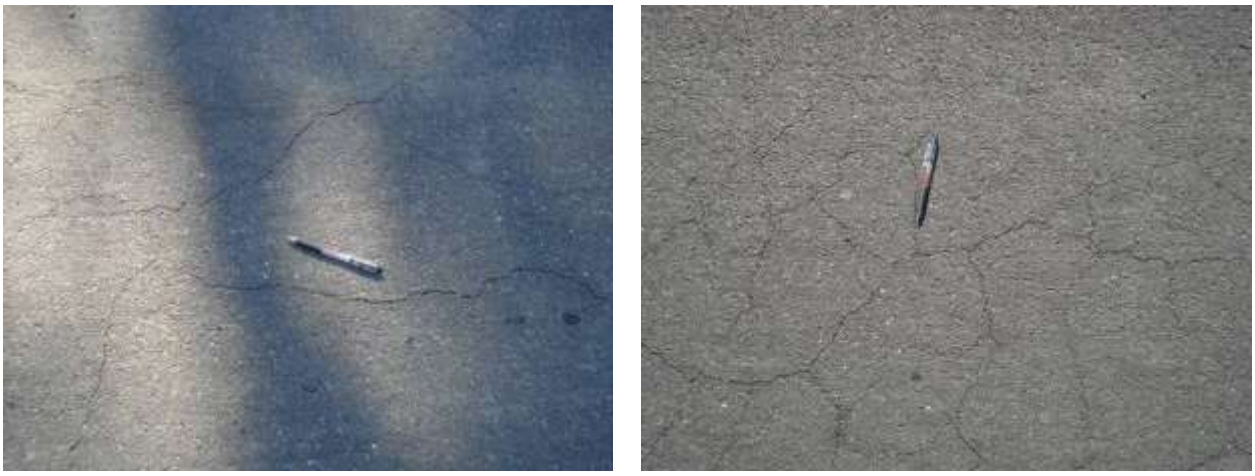


Figure 16. Reflection cracks in section 4

5.0 Material Testing Results from Cores

5.1 Binder Properties of Recovered Asphalt from Cores

In order to find out any property changes due to the cape seal applications, some cores were sent to the Asphalt Pavement and Recycling Technologies (APART) laboratory for testing the viscosity and penetration of the recovered existing pavement binder. First the cape seal portion was removed from each specimen, and then the next 3/8-inch of each core was removed for testing. The asphalt was extracted and recovered as prescribed by California Test Method 365 (CTM 365). Viscosities were determined on the recovered asphalt binder using a sliding plate microviscometer (CTM 348). Penetrations were calculated using Pfeiffer's nomograph. Test data are shown in Table 2.

The results show that both Styraflex and PASS treated binders in the existing pavement are all highly oxidized. All viscosities are very high and penetration values are low. There is not a significant rejuvenating effects with these cores. This would suggest the PMRE are not performing much of a rejuvenating function. What was surprising was that there was no difference in the hardness of the binders recovered from the fabric and not fabric sections. It was hypothesized that the sections with fabric would be harder than those without fabrics. This was not the case. This finding could be due to the fact that the cores were not taken over a crack in the underlying pavement. Had a core been taken over a crack, more of the PRME would have been found in the crack and the likelihood of some softening could have occurred.

Table 2. Viscosity and Penetration of recovered existing pavement binder

	Viscosity, 60ºC, Poises	Penetration, 25ºC, dmm*
#3	>4,000,000	<2
#6	>4,000,000	<2
#8	>4,000,000	<2
#10	>4,000,000	<2

*Calculated using Pfeiffer's nomograph.

5.2 Permeability Testing Results of Cores

The objective of the permeability tests of the cores is to find the water sealing abilities of various cape seal treatments. The following sections describe the test procedures and results.

5.2.1 Permeability Testing Procedures

The procedures used to measure permeability are based on the Florida Method to Test for Measurement of Water Permeability of Compacted Asphalt Paving Mixtures. A summary of the procedure is presented below:

1. Soak the asphalt concrete core to be tested a minimum of 2 hours prior to testing.
2. Place a container filled with water under the drain on the base of the permeameter; the container must be tall enough that its water level will always be higher than the drain. This container must be continually overflowing during testing.
3. Attach the sealing tube to the vacuum on the base of the permeameter and pump the air out.
4. Slowly fill the base plate of the permeameter with water and close the drain. Open and close the drain quickly to bleed out any trapped air.
5. Center the core on the base plate.
6. Wrap a piece of duct tape around the diameter of the core to protect the membrane from sharp points on the core.
7. Place the sealing tube on the permeameter base around the core.
8. Press the cap down into the sealing tube to meet the sample.
9. Put the clamp on the permeameter and tighten.
10. Put an inch of water in the sealing tube above the cap.
11. Attach the sealing tube to the pump and pump the pressure up to 10 ± .5 psi.
12. Fill the graduated cylinder protruding from the cap half full with water.
13. Rock the permeameter back and forth and sideways at least 25 times to remove air bubbles trapped in the sealing tube.
14. Fill the graduated cylinder the rest of the way above the 62.4 cm mark.
15. To assure that the core is saturated place hose at the top of the graduated cylinder and open the valve in the base of the permeameter. Adjust the flow of water from the hose to match the out flow of the valve. Let the water run with the valve open for 30 minutes for a dense grade core or 10 minutes for an open grade core.
16. Begin testing by closing the valve in the base of the permeameter and filling the graduated cylinder above the 62.4 cm mark. Open the valve and begin timing with a stopwatch when the water level drops to the 62.4 cm mark.
17. Stop the timer when the water level reaches 5 cm. If the water level does not reach 5 cm in 30 minutes record the water level height at 30 minutes.
18. Use the equation given below to calculate the permeability.

$$Permeability = \left[\left(\frac{ah}{At}\right) \times ln\left(\frac{h1}{h2}\right)\right] \times p$$

a= cross sectional area of graduated tube
h= average height of core
A= cross sectional area of core
t= time
h_1= initial height of water in graduated tube
h_2= final height of water in graduated tube
p= temperature correction factor

5.2.2 Permeability Testing Results

Table 3 summarizes the results of the permeability tests of the various cores. Cores 1-3 are from the section with PASS and a fabric. Cores 4-6 are from the section with PASS and no fabric. As can be seen from Table 3 the permeability varies considerably in these tests with most of the test results showing the product to be relatively impermeable (except for core 2).

Cores 7-9 are the Styraflex product without fabric while cores 10-12 are the same product with fabric. This product is generally more permeable (especially for core 7) and the presence of the fabric does not seem to have much of an effect.

These results clearly show that the PASS is generally less permeable than the Styraflex. This means there should be less water or oxygen getting into the pavement, which would extend the life of the treatment.

Table 3. Summary of permeability values for the City of Woodland Cape Seal test sections

Sample No.	Core Location	Product Application Date	Core Date	Average Thickness (cm)	Temperature Corrected Permeability (cm/s)
1	Test Section 1	2009	2011	1.431	3.22597E-07
2		2009	2011	1.434	6.08546E-04
4	Test Section 3	2009	2011	1.242	8.48967E-08
5		2009	2011	1.368	5.38526E-06
7	Test Section 4	2009	2011	1.060	1.22310E-03
9		2009	2011	1.386	2.26808E-05
11	Test Section 2	2009	2011	1.291	1.07907E-05
12		2009	2011	1.499	9.92304E-06

5.3 Laboratory Asphalt Pavement Analyzer (APA) Testing on Cores

The APA wheel tracking test was used to evaluate the rutting and crack resistance properties of the different cape seals. The following sections describe the test procedures and results.

5.3.1 Laboratory Fatigue Testing using Asphalt Pavement Analyzer (APA)

The intended purpose of this laboratory test is to show potential differences in the performance of different Cape Seal applications placed in the City of Woodland in 2009. Six-inch diameter cores were taken from the test sections during the fall of 2011. The four test sections were placed using two

different products. Each product had a one test section placed using a fabric prior to the cape seal and a second test section which did not use fabric.

A performance based fatigue test utilizing the Asphalt Pavement Analyzer (APA) was used due to its ability to apply load to pavement samples by means of a tracking wheel in a cyclic manner while recording force, deflection, and number of tracking wheel passes. The surface layer varied in thickness between .42 inches (10.67mm) and .63 inches (16 mm) thick. The pavement below this surface treatment was badly cracked, aged, and very brittle asphalt pavement. The top 0.5 inch (12.7 mm) of the provided pavement sample cores was removed using a large masonry saw and saved for testing.

Cylindrical molds designed to complete a standard rut test using the APA were used for this testing. Photos of the mold are shown in the Figure 17 below.

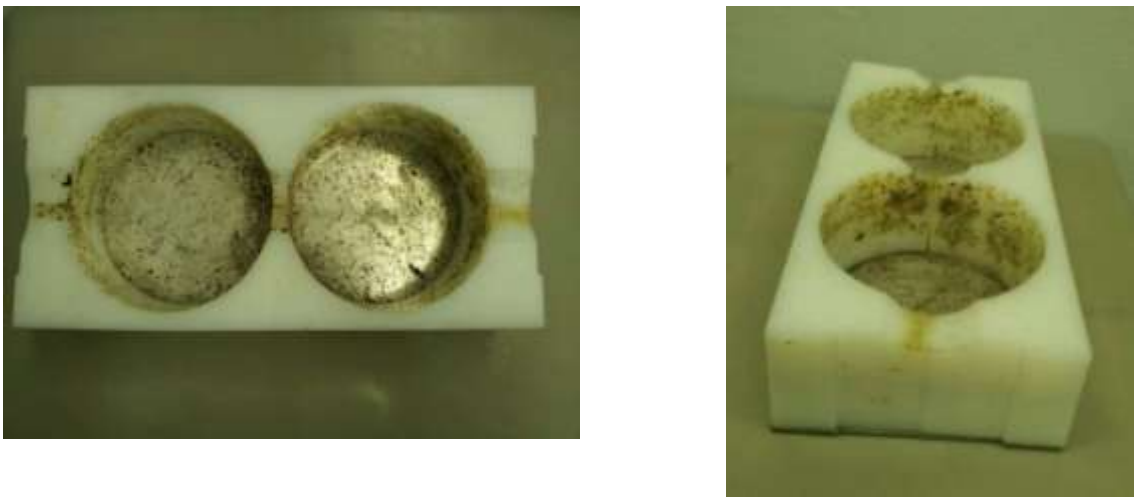


Figure 17. Mold used for testing (top and side view)

A small support was constructed to fit inside of the circular receptacle in the mold to allow for a beam type testing of the 0.5 inch thick pavement core samples. This support was constructed using plywood. The support was constructed to have a clear span of 3 inches. The support is shown below in Figure 18.

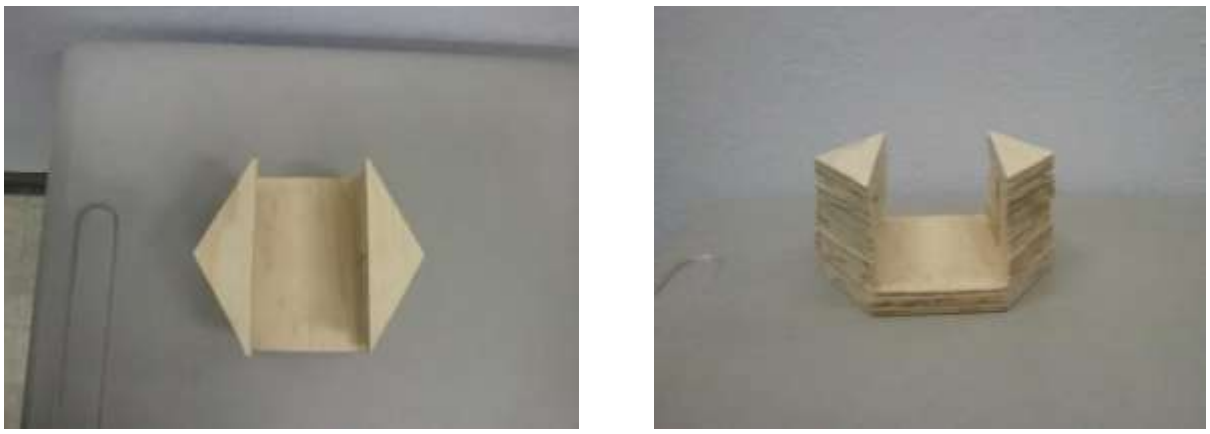


Figure 18. Support for testing (top and side view)

The support with a sample placed on top is shown in Figure 19.

Figure 19. Support with sample placed on top (top and side view)

The support installed into the mold is shown in Figure 20 with and without practice samples on top.

Figure 20. Support installed in mold with and without practice sample placed on top (side view)

A linear hose rack installed in the APA was used for testing. The linear hoses are capable of being pressurized and are in contact with the top of the core samples during testing. A steel wheel applies load to the pressurized hose while tracking back and forth during testing. A photo of this rack system on top of the core samples in the mold with the support system is shown in Figure 21.

Figure 21. Core samples and linear hose rack installed in APA prior to testing

In order to get accurate data a single support with a core sample placed on top of it was used instead of using both circular receptacles. Additional practice core samples were placed in the second circular receptacle in order to maintain a similar height, but a support system was not used.

Once the pavement core samples were installed into the APA the test settings were applied and the test started. The test settings used are as follows:

- Hose pressure: 100 psi
- Applied load: 80 lbs
- Test duration: cycle until failure (cracked sample)

Practice cores were used to experiment with the applied loads and test duration to guide the completion of actual Woodland core testing.

5.3.2 APA Rutting and Fatigue Testing Results

This section presents the APA testing results of the testing on the City of Woodland core samples taken in the field, while the previous section introduced experiment design and practice testing. Table 4 shows the average core thickness and number of cycles completed to reach a measured rut depth of 7.0mm. Core number 7 broke in half during testing with less than 10 cycles. This core sample also had the lowest average thickness.

Figure 22 shows a graph plotting the average thickness of the cores against the number of cycles completed to achieve a 7.0mm measured rut depth. From Figure 22, the number of cycles to the same rut depth of 7.0 mm is directly related to the thickness of the cores; That is, the thicker the core, the higher the number of cycles to the same rut depth.

Table 4. Woodland APA Test Data

	Average Thickness (mm)	Number of Cycles	Rut Depth (mm)
Core 1	14.512	934	7.009
Core 2	13.986	857	7.008
Core 4	16.04	1922	7.024
Core 5	13.46	166	7.008
Core 7	10.814	<10	Broke in half
Core 9	13.768	689	7.054
Core 11	13.592	567	7.007
Core 12	14.434	328	7.021

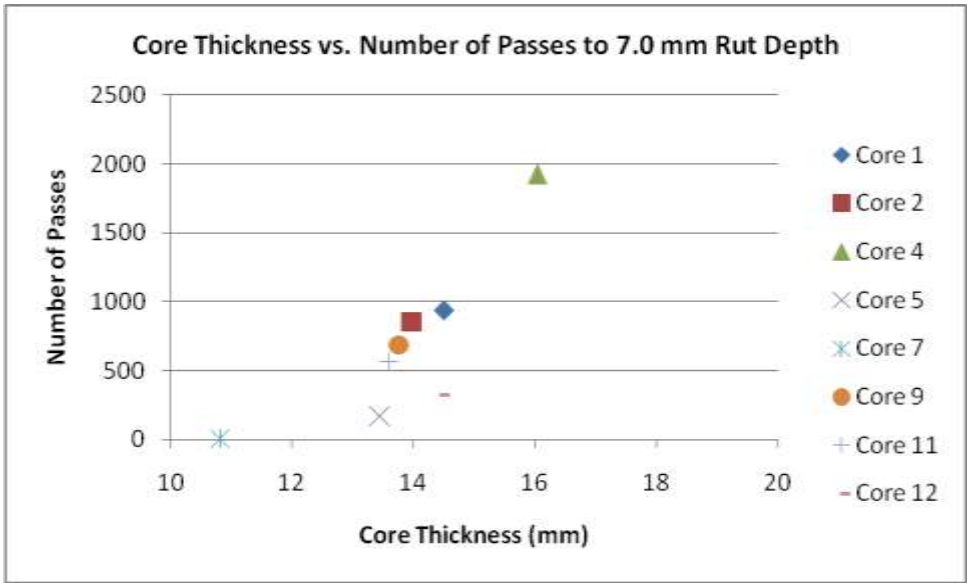


Figure 22. Woodland APA Test Data

In order to compare the fatigue effectiveness of different test sections, Table 5 was created to show the number of load cycles required to reach a deflection value of about half of the thickness of each core sample. This will reduce the impact of thickness on the results of APA fatigue testing. By visual inspection of the core samples, Cores 2, 5, and 7 have some defects, while others are in very good condition. The APA testing results show that Cores 2, 5, and 7 had relative low number of cycles.

Table 5. Summary of load cycles to rutting about half of core thickness

Core Number	Section Number	Average Thickness (mm)	Rut Depth to about half of thickness (mm)	Number of Cycles at rutting about half of core thickness
Core 1	Section 1	14.512	7.261	1009
Core 2		13.986	6.993	851
Core 4	Section 3	16.04	8.019	2357
Core 5		13.46	6.74	154
Core 7	Section 4	10.814	Broke in half	<10
Core 9		13.768	6.906	682
Core 11	Section 2	13.592	6.799	544
Core 12		14.434	7.214	350

Note: (1) Core 2 has hairline crack on face of core approx. 2 in. long, fabric visible on back on core, small voids in binder over approx. 15% of core back. (2) Core 5 has hair line cracks run from the perimeter of the front face towards its center, a crack runs across the face of the back face of the core. (3) Core 7 has one hair line crack near an edge of the front face, small voids in binder over about 10% of back core face.

Based on the results in Table 5, Sections 1 and 3 which used product A (PASS) have better performance than Sections 2 and 4 which used product B (Styraflex). Using a fabric doesn't seem to help with the fatigue life of the cape seal.

6.0 Conclusions and Recommendations

6.1 Conclusions

Based on the pavement condition observation and roadway information, the following conclusions can be drawn:

1. The existing pavement prior to placing the Cape Seal was in poor or very poor condition. The Cape Seals improved the pavement conditions by reducing the number and severity of cracks. However, different products applied in this test strip performed differently.

2. The PASS scrub micro cape seal performed better than the Styraflex scrub micro seals. Under this poor pavement condition, the Styraflex scrub seal began to show some cracks after a few months while the PASS section held up for several years.

3. Treatments with fabric performed about the same as the non fabric, in part because the fabric prevented the penetration of polymer modified rejuvenating emulsion (PMRE) into the existing cracks. If a fabric were used, there is no need to use the expensive PMRE.

4. The tests on the recovered asphalt from the underlying asphalt pavement showed no difference in the products. All of the test sections are badly oxidized. However, had cores been taken over existing cracks in the asphalt pavement, more of an effect might have been found.

5. There are some differences in the permeability between the various products and with and without fabrics. Generally, PASS has lower permeability than Styraflex. The fabric didn't affect much on the permeability of the PMRE products. Lower permeability values mean that the pavement will let in less water or air.

6. Testing using the APA system showed there were differences in the rutting and fatigue properties. The thickness of the layer has a big impact on the rutting and fatigue of the Cape Seal treatment. The thicker the treatment, the longer the fatigue life and less rutting. APA testing results also showed that the PASS product had better fatigue life than Styraflex based on the number of load cycles to rutting of about half of core thickness.

7. The APA testing results are consistent with the permeability testing results.

6.2 Recommendations

The following are the recommendations from this study:

1. PMRE scrub seals should be more effective without the use of fabric. It is recommended that when rejuvenating is desired, fabrics not be used. If waterproofing is desired, then fabrics could be used in combination with the scrub seals.

2. The City should continue to monitor the long term performance of the test sections to obtain the treatment life information.

3. A life cycle cost analysis is recommended to further evaluate the cost effectiveness of the two different products. The life cycle cost analysis considers both construction costs and long term performance. We would need the estimated lives for both products. At this point in time it would be expected that the PASS would last longer than the Styraflex alternative.

7.0 References

1. Katie Wurzel, 2008 Road Program Report, Public Works Department, City of Woodland, March 2008

2. Tami Burnham, Photos for preconstruction condition and pavement conditions in 2009 and 2010.

3. Florida Method of Test for Measurement of Water Permeability of Compacted Asphalt Paving Mixtures. FM 5-565 September 1, 2000, Revised January 26, 2006.

4. Asphalt Pavement Analyzer (APA) User's Guide Updated 4-11-08. Pavement Technology Inc. Covington, GA.

Appendix

Appendix A: Specification for PMRE Scrub Seal

Appendix B: Specification for Micro-surfacing

Appendix C: Specification for Paving Fabric

SECTION O. POLYMER MODIFIED ASPHALT REJUVENATING SCRUB SEAL

(COMBINATION BID ITEM'S NO. 5, 6, 8, &A3)

O-1 GENERAL

The work shall consist of but not be limited to furnishing all labor, materials, equipment and material for the application of the polymer modified asphaltic rejuvenating emulsion. Application of aggregate to conform with Section 37-1 of the State Standard Specifications and these Special Provisions unless otherwise specified herein.

The work shall be done in the following order: Preparing the pavement surface; applying the polymer modified asphaltic rejuvenating emulsion and scrubbing the applied emulsion with a scrub broom as specified herein; applying aggregate, brooming the aggregate with a secondary broom when specified, rolling the aggregate; and sweeping up and disposing of excess aggregate off of the job site.

When used in Bid Items No. 6 & A3, the scrubbing requirement for this process shall be omitted as to not damage the fabric placed as the base course for these bid items.

O-2 PREPARATION

Contractor shall prepare the streets according to Section N - Surface Preparation in its entirety before surfacing work can begin.

O-3 QUALIFICATIONS

The Contractor shall have had a minimum of three (3) years experience in the application of polymer modified asphaltic emulsion as applied to scrub-seal; and have completed at least three (3) scrub-seal projects using the scrub-broom to the satisfaction of their clients.

O-4 APPLICATION

All incidental work such as surfacing of driveway aprons and the area abutting the curb returns shall be done concurrently with the surfacing of the street proper. The scrub seal shall be applied 12"-18" from the lip of the gutter. Where a curb exists without gutter, the scrub seal shall be applied 12"-18" from the face of curb when receiving a cape. If a cape is not specified then the scrub seal shall be placed from edge of pavement to edge of pavement. Where no curb or gutter exists, the scrub seal shall be applied from edge of pavement to edge of pavement. The edges of the limits of the scrub seal application on both sides of the street shall be maintained in a neat and uniform line. Scrub seal shall not be applied on concrete gutters or pads unless directed by the Engineer.

The application of the polymer modified asphaltic rejuvenating emulsion shall be applied when ambient temperature is above forty (40) degrees Fahrenheit and rising. The polymer

modified asphaltic rejuvenating emulsion shall not be placed if the ambient temperature during the twenty four curing period (24) hours is expected to be below twenty-five (25) degrees Fahrenheit. The termination time of application shall be determined by the Engineer.

The areas to be scrub sealed shall have the polymer modified asphaltic rejuvenating emulsion applied with a distributor truck to the pavement surface at a rate of 0.25 to 0.35 gallons per square yard. The actual emulsion application rate shall be required by the surface demands and aggregate used. The application of the emulsion shall be determined by the Contractor's representative. For cul-de-sacs, turnout pockets and elbows the application rate may be adjusted down from the rate established for the main roadway.

The polymer modified asphaltic rejuvenating emulsion temperature when applied shall be at a minimum of 110 degrees Fahrenheit. For smaller areas the emulsion may be applied with a wand. The emulsion shall be immediately scrubbed or broomed to fill cracks and voids. The emulsion scrub broom shall be as described in Section O-6 Equipment:

The application of the polymer modified asphaltic rejuvenating emulsion and scrub broom operation shall cease 40' (ft) prior to the end of the street section or intersection. The remaining polymer modified asphaltic rejuvenating emulsion shall be drug out by the scrub broom, and the remaining emulsified material required to complete the pass shall be applied only by the spread truck (boot truck), at the specified rate.

Under no circumstances will the boot truck be allowed to lead the chip distributor truck by more than 200 feet.

Immediately following the application of the emulsion to the road surface, the material shall be scrubbed with a scrub broom for the purpose of forcing the emulsion into the existing surface and distributing the emulsion evenly over variable road surface contours.

Immediately following the scrubbing of emulsion, aggregate shall be applied at the rate specified. The rate shall be adjusted up or down so that no "bleed through" occurs during rolling.

The aggregate shall be spread evenly by a mechanical spreader as described in Section N-6 Equipment.

Aggregate Application Rate:

For Grading A = 18 – 24 lbs / sy
For Grading B = 20 – 27 lbs / sy
For Grading C = 22 – 31 lbs / sy

A minimum of three (3) complete coverages with (minimum) 5-ton pneumatic tired rollers are required. Not less than two (2) self-propelled pneumatic-tired rollers shall be used on any street for the required rolling of the aggregate to maximize uniform compaction. The initial coverage with the pneumatic-tire rollers shall commence once the aggregate screenings are being placed and compacted to maximum compaction and uniformity within 30 minutes or as directed by the Engineer. The pneumatic-tired rollers shall be operated in such a manner to prevent dislodging newly applied aggregate and at no time should speeds exceed 6 mph.

Power sweeping shall be done after the second but before the end of the third day after scrub seal operation to remove any excess loose aggregate. During the sweeping process the Contractor shall use a backpack blower to clear driveways, gutters and sidewalks of excess aggregate at the end of each day until the street is microsurfaced. **The Contractor shall wait a minimum of seven (7) days and a maximum of fourteen (14) days after the scrub seal application before applying other surface treatments as specified.**

The Contractor shall exercise care to prevent oil from being deposited on concrete surfaces. Each day the Contractor shall remove oil from the surfaces not designated to cape sealed. No additional streets shall be scrub sealed until this clean up has been performed. The method of the oil removal shall be approved by the Engineer.

Contractor shall install temporary raised pavement markers once the scrub seal is cured until the roadway surface is ready for permanent raised pavement markers.

O-5 STOCKPILE SITES AND CONSTRUCTION ZONE

The sites for stockpiling shall be clean and free of objectionable materials and shall be located outside the street right-of-way. Arrangements for these sites shall be the responsibility of the Contractor. If on private property, a written agreement shall be provided to the Engineer prior to commencing operations. For purposes of this contract the construction zone is defined to be the stockpile area, the area to be sealed, and all streets and public rights-of-way in between.

O-6 EQUIPMENT

The equipment to be used for the scrub-seal shall be as follows

(a) Asphalt Emulsion Distributor Truck for application of the emulsion shall have a full circulation spray bar that is adjustable to at least sixteen (16) feet wide in two (2) feet increments and capable of heating and circulating the emulsion simultaneously. It must have computerized rate control for adjusting and controlling the application from the cab that is adjusting by .01 gallons per square yard increments. The distributor shall also be equipped with a volume measuring devise and a thermometer for measuring the emulsion temperature in the tank. If there are cul-de-sacs in the project area, at least one

of the asphalt distributor trucks shall be capable of placing emulsion around the perimeter of a cul-de-sac that is 80' in diameter or larger in one continuous pass.

(b) Scrub Broom frame shall be constructed of metal. The scrub broom shall be attached to and pulled by the distributor truck. The scrub broom must be equipped with the means to mechanically raise and lower the scrub broom off and onto the road surface at designated points of completion and start up. It shall be tow able in the elevated position to the next area of construction. The weight of the broom assembly shall be such that it does not squeegee the emulsion off the roadway surface.

The main body of the scrub broom shall be a frame minimum 6'-9" wide, 10' (ft) deep. The maximum transverse rigid frame width at any point shall not exceed 6'-9". The nearest and furthest members, paralleling the back of the spreader truck, and diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have broom heads angled at 10 to 15 degrees off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the scrub broom assembly shall be 3 ½" w x 61/2" h x 16" L and have stiff nylon bristles. Bristle height is to be maintained at a minimum of 5". The scrub broom shall be equipped with hinged wing assemblies attached to the main body not to exceed 4'-6" (ft) per side, with diagonals and equipped with street brooms. The purpose of the maximum rigid frame width and the hinged wing extensions is not only for maximum width of 16' (ft) but to maintain the scrubbing process evenly as contours and cross-sections change across the existing road surface .

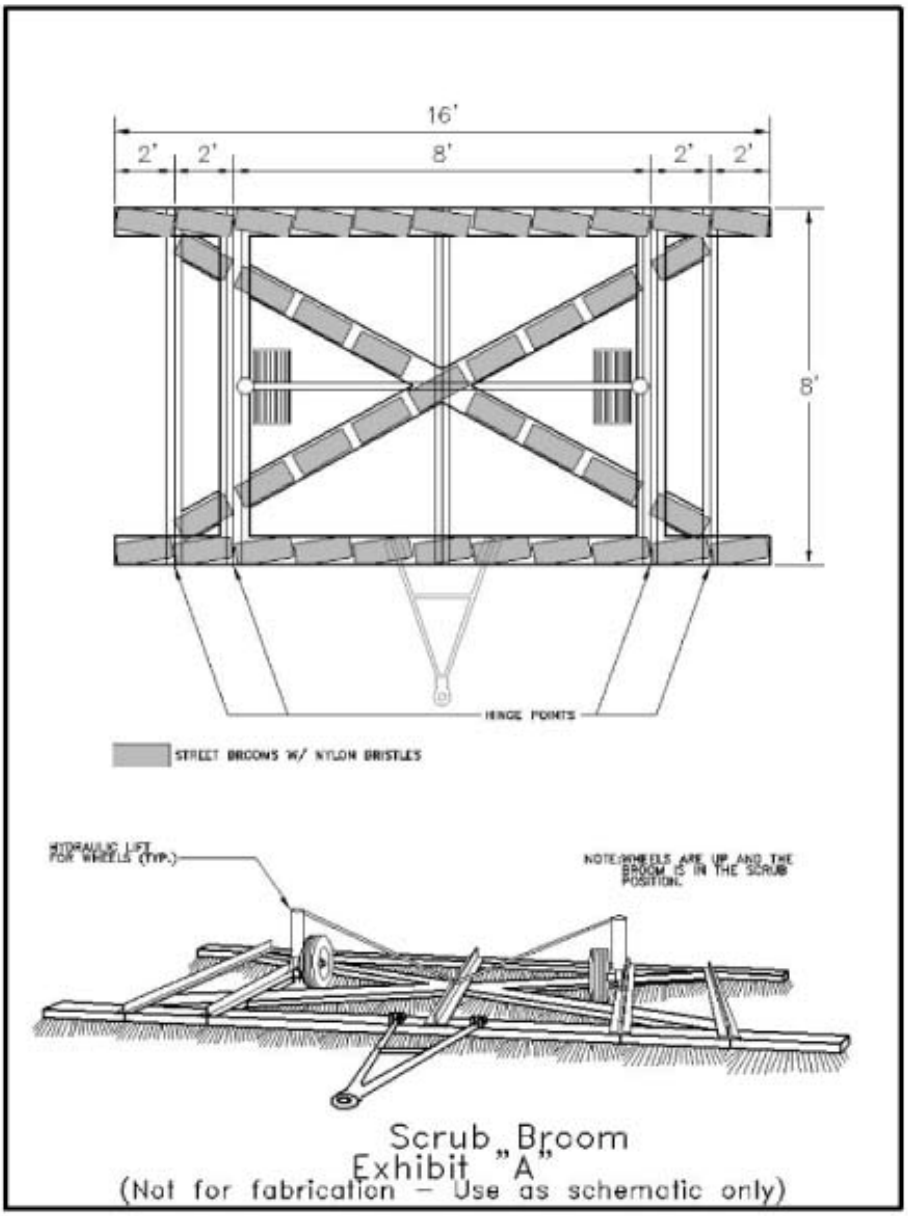
The contractor shall supply a scrub broom as described for the purpose of scrubbing the polymer modified asphaltic rejuvenating emulsion. If the Contractor fails to supply the scrub broom specified, the project shall be shut down until the contractor supplies the required equipment in full operation. Shut downs resulting from the failure to provide this specified scrub broom shall not excuse the Contractor from the provisions of contract working days.

(c) Self-Propelled Computerized Aggregate Spreader equipped with an aggregate receiving hopper in the rear, belt conveyors to carry the aggregate to the front, and a spreading hopper equipped with a full-width distribution auger and spread roll. The spreader shall be in good mechanical condition and be capable of applying the cover material uniformly across the spread at the specified rate in a single application.

(d) A minimum of two (2) pneumatic rollers weighing at least five (5) tons each.

(e) Two (2) mechanically powered kick-brooms or vacuum type brooms.

(f) A back pack blower for removing excess chips during the sweeping operation.



O-7 MATERIALS

POLYMER MODIFIED REJUVENATING EMULSION

The asphalt emulsion shall be a polymer modified rejuvenating Emulsion with a polymer, rejuvenating agent and asphalt and shall meet the following specifications.

Test on Emulsion	**Method**	**Specification**
Viscosity @77 (SFS)	ASTM D244	50 - 350
Residue, w%, minimum.	ASTM D244	67
pH	ASTM E70	2.0-5.0
Sieve, w%, max.	ASTM D244	0.1
Oil distillate, w%, max.	ASTM D244	0.5
Test on Residue(1)		
Viscosity @ 140°F, (P), maximum.	ASTM D2171	3000
Penetration @ 39.2°F,minimum.	ASTM D5	40
Elastic Recovery on residue by distillation, %, minimum.	AASHTO T59, T301 (1,2)	60
Test on Latex:		
Specific Gravity	ASTM 1475	1.08 – 1.15
Tensile strength, die C dumbbell, psi, minimum	ASTM D412 (3)	500
Swelling in rejuvenating agent, % maximum; 48 hours exposure @ 104°F	ASTM D471(4) Modified	40% intact film
Test on rejuvenating agent:		
Flash point, COC , °F	ASTM D92	> 380
Hot Mix Recycling Agent Classification	ASTM D4552	See Section II

(1) Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350° F plus or minus 10° F. Maintain at this temperature for 20 minutes. Complete total distillation in 60 plus or minus 5 minutes from first application of heat.

(2) Elastic Recovery @ 10° C (50° F): Hour glass sides, pull 20 cm, hold 5 minutes then cut, let sit 1 hour.

(3) Tensile Strength Determination: Samples for testing for tensile strength in accordance with ASTM D412 shall be cut using a die dumbbell at a crosshead speed of 20 in/min.

(4) Latex Testing: Suitable substrate for film formation shall be polyethylene boards, silicone rubber sheeting, glass, or any substrate which produces a cured film of uniform cross-section. Polymer film shall be prepared from latex as follows:

Resistance to Swelling: Polymer films shall be formed by using a 50 mil drawdown bar and drawing down 50 mils of the latex on polyethylene boards. Films shall be cured for 14 days at 75°F and 50% humidity. Samples for resistance to swelling in rejuvenating agent shall be 1" by 2" rectangles cut from the cured film. Cut at least 3 specimens for each sample to be tested for swelling. Fill 3- 8 oz ointment tins with at least a ½" deep of rejuvenating agent. Swelling samples shall be weighed and then placed in the ointment tins on top of the rejuvenating agent. Then, add at least another ½" deep of rejuvenating agent over each of the latex samples. The ointment tins shall be covered and placed in an oven at 104°F for the specified 48 hours +/- 15 minutes. The ointment tins are allowed to cool to 75°F and then the latex films are removed from the tins. Unabsorbed rejuvenating agent is removed from the intact latex film by scraping with a rubber policeman and blotting with paper towels. If the latex film does not remain intact during removal from the tins or while removing the unabsorbed rejuvenating agent the sample shall be rejected. After the rejuvenating agent is removed from the samples they are then weighed. Percent swelling is reported as weight increase of the polymer film; report mass increase as a percent by weight of the original latex film mass upon exposure of films to the recycling agent.

(a) RECYCLING AGENT

The recycling agent shall meet the following specification:

Test	Specification
Viscosity, 140F, CST	50-175
Flash Point, F, COC	380 Min.
Saturate, % by wt.	30 Max
Asphaltenes	1.0 Max.
Test on Residue	
Weight Change, %	6.5 Max.
Viscosity Ratio	3 Max

(b) AGGREGATE

The Aggregate Screenings shall conform to the following requirements prior to placing on the roadway.

***Screening Aggregates – shown by Grading Type and % passing**

Grading		A 1/4 X #10	B 5/16 X #8	C 3/8 X #6
1/2	(12.5 mm)	100	100	100
3/8	(9.5 mm)	100	100	90 - 100
#4	(4.75mm)	60 - 80	35 - 55	5 - 20
#8	(2.36mm)	0 - 15	0 -10	0 - 7
#16	(1.18mm)	0 - 5	0 - 5	0 - 5
#30	(600 um)	0 - 4	0 - 4	0 - 4
#200	(75 um)	0 - 3	0 - 3	0 - 3

* Grading Type shall be that specified in the Bid Schedule

Screenings shall also conform to the following quality requirements:

Test	California Test	Requirements
Los Angles Rattler Loss at 500 rev. (max.)	211	40%
Cleanness Value (min.)	227	80
Percentage of Crushed Particles	205	100%

(c) MATERIAL CERTIFICATIONS AND TESTING

The emulsion manufacturer, through the contractor, shall submit to the agency certification that the emulsion meets the specification. The latex manufacturer, Polymer Science of America, through the emulsion supplier and the contractor, shall submit to the agency test results from the specified laboratory, certification that the latex is cationic and meets the required specifications and that it is supplying the latex for this project. The agency will not accept test results dated more than 90 days from the date of bid opening.

The *refinery refining the recycling agent, through emulsion supplier and the contractor shall submit to the agency test results on the recycling agent and certification that the recycling agent meets the required specifications.

*The refinery supplying the certification must be an affiliate or subsidiary of an approved Caltrans asphalt supplier. This requirement insures that the product supplied is refined under a Quality Assurance and a Quality Controlled Environment required by Cal-Trans."

Polymer film's required for testing must be prepared in accordance with this specification by Momentum Technologies Inc., 1507 Boettler Rd., Uniontown, OH 44685. The polymer films used for testing shall be derived from the same 1 quart sample received from the manufacture of the latex. Both the swell test and the tensile test shall be performed by Momentum Technologies Inc. The refinery manufacturing the recycling agent shall submit to the laboratory testing the latex a one quart sample of the recycling agent for use in the swell test.

Certifications and test results on the latex and the recycling agent shall be submitted and attached to the bid proposal.

Certifications and test results on the emulsion must be submitted to the agency and approved by the agency ten (10) days prior to supplying material.

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The recycling agent used for the test will be supplied and certified by TRICOR Refining located in Bakersfield California."

Prior to and during the project the agency will require one quart samples of both the finished emulsion and the latex used in the emulsion to be submitted to the agency daily or when new material arrives on site.

O-8 PAYMENT

Payment for Polymer Modified Asphaltic Rejuvenating Emulsion Scrub Seal shall be included in the combination bid items no. 5, 6, 8, & A3, and shall be paid based on the final measure of Section N - Polymer Modified Slurry Seal or Section P - Microsurfacing and no other compensation will be given.

Basis for rejection of scrub seal includes, but is not limited to, improper placement of material, striation of surface, “balling” of material due to quick-set, and tracks of vehicles, bicycles and pedestrians.

The contract price shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the slurry seal, complete in-place, as specified in these specifications and as directed by the Engineer.

END OF SECTION

SECTION P. MICROSURFACING

(BID ITEM'S NO. 7, B3, C3 &D3COMBINATION BID ITEM'S NO. 8, and A3,)

P-1 DESCRIPTION

Micrsurfacing is a mixture of polymer modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed and spread on a paved surface in accordance with these specifications.

The mix should be capable of being spread in variable thick cross sections (wedges, ruts, scratch courses and surfaces), which, after curing and initial traffic consolidation, resists compaction throughout the entire design tolerance range of bitumen content and variable thickness' to be encountered. The end product should maintain a friction resistant surface (high wet friction co-efficient) in variable thick sections throughout the service life of the microsurfacing.

This mix is to be a quick traffic system, meaning that it will be able to accept traffic after a short period of time. The amount of time will vary from job to job and must be evaluated on an individual job basis. This system shall be required to accept rolling traffic on a one-half (1/2) inch (12.7 mm) thick surface within two hours after placement in +75º F (24º C) temperature and 50% or less humidity.

P-2 MATERIALS

(a) EMULSIFIED ASPHALT

(i) GENERAL

The emulsified asphalt shall be a rapid set polymer modified asphalt emulsion conforming to the requirements specified in AASHTO M208 or ASTM D2397 for PMCRS2h as specified in Section 94, "Asphaltic Emulsions," of the Standard Specifications.

The cement-mixing test shall be waived for this emulsion.

The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process.

The minimum amount and type of polymer modifier shall be determined by the laboratory performing the mix design. The minimum amount required will be based on asphalt weight content and will be certified by the emulsion supplier. In general, a three percent (3%) polymer solids, based on asphalt weight, is considered minimum.

The five-day settlement test may be waived, provided job stored emulsion is used within thirty-six (36) hours from the time of the shipment, or the stored material has had additional emulsion blended into it prior to use.

(ii) QUALITY TESTS

When tested according to the following tests, the emulsion shall meet the requirements of AASHTO M208 OR ASTM D2397 for PMCRS2h, plus the following:

TEST	QUALITY	SPEC
AASHTO T59 ASTM D244	Residue by Evaporation	62% min

The temperature for this test should be held below 280º F (138º C). Higher temperatures may cause the polymers to break down.

TESTS ON RESIDUE

TEST	QUALITY	SPEC
AASHTO T53 ASTM D36	Softening Point	135º F (57º C) min
AASHTO T49 ASTM 2397	Penetration at 77º F (25º C)	40-90
AASHTO TP 5	G* @ 20º C, 10 rad/sec, Mpa	Report Only
AASHTO TP 5	Phase Angle @ 50º C, 10 rad/sec, PA(max) – PA base	Report Only
AASHTO TP 1	Stiffness @ -12º C, Mpa, and M-value	Report Only

Climate conditions should be considered when establishing this band.

ASTM 2170	Kinematic Vis. @ 275º F (135º C)	650 cSt/sec. min.

Each load of emulsified asphalt shall be accompanied with a certificate of analysis/compliance to assure that it is the same as that used in the mix design.

(b) AGGREGATE

(i) GENERAL

The mineral aggregate used shall be of the type and grade specified for the particular use of the microsurfacing. The aggregate shall be a manufactured crushed stone such as granite, slag, limestone, chat, or other high quality aggregate, or combination thereof. To assure the material is totally crushed, 100% of the parent aggregate will be larger than the largest stone in the gradation to be used.

(ii) QUALITY TESTS

When tested according to the following tests, the aggregate should meet these minimum requirements.

TEST	QUALITY	SPEC
AASHTO T176 ASTM D2419	Sand Equivalent	65 min
AASHTO T104 ASTM C88	Soundness	15% max. using NA2 S04 or 25% max using MgS04
AASHTO T96 ASTM C131	Abrasion Resistance	30% max.

The abrasion test is to be run on the parent aggregate. The aggregate should meet state approved polishing values.

(iii) GRADING

When tested in accordance with AASHTO T27 (ASTM C136) and AASHTO T11 (ASTM C117), the target (mix design) aggregate gradation (including the mineral filler) shall be within one of the following bands.

ISSA

Sieve Size	Type II Percent Passing	Type III Percent Passing	Stockpile Tolerance
3/8 (9.5mm)	100	100	
#4 (4.75 mm)	90-100	70-90	+ or – 5%
#8 (2.36 mm)	65-90	45-70	+ or – 5%
#16 (1.18 mm)	45-70	28-50	+ or – 5%
#30 (600 um)	30-50	19-34	+ or – 5%
#50 (330 um)	18-30	12-25	+ or – 4%
#100 (150 um)	10-21	7-18	+ or – 3%
#200 (75 um)	5-15	5-15	+94 – 2%

The job mix (target) gradation shall be within the gradation band for the desired type. After the target gradation has been submitted (this should be the gradation that the mix design is based on) then the percent passing each sieve shall not vary by more than the stockpile tolerance shown in the above table for each individual sieve, and still remain within the gradation band. It is recommended that the percent passing shall not go from the high end to the low end of the range for any two consecutive screens.

The aggregate will be accepted at the job location stockpile or when loading into the support units for delivery to the laydown machine. The stockpile shall be accepted based on five gradation tests according to AASHTO T2 (ASTM D75). If the averages of the five tests are within the gradation tolerances, then the materials will be accepted. If the tests show the material to be out, the contractor will be given the choice to either remove the material or blend other aggregate with the stockpile material to bring it into specifications. Materials used in blending must be the quality tests before blending and must be blended in a manner to produce a consistent gradation. If blending is used it will require that a new mix design be performed.

Screening shall be required at the stockpile prior to delivery to the paving machine, if there are any problems created by having oversize material in the mix.

(c) MINERAL FILLER

Mineral filler, if required, shall be any recognized brand of non-air entrained Portland cement or hydrated lime that is free from lumps. It may be accepted upon visual inspection. The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation. An increase or decrease of less than one percent (1%) may be permitted when the microsurfacing is being placed, if it is found to be necessary for better consistency or set times.

(d) WATER

The water shall be potable and free of harmful soluble salts or reactive chemicals and any other contaminates.

(e) ADDITIVES

Additives may be added to the emulsion mix or any of the component materials to provide the control of the quick-traffic properties. They must be included as part of the mix design and be compatible with other components of the mix.

P-3 LABORATORY EVALUATION

(a) GENERAL

Before the work commences, the contractor shall submit a signed mix design covering the specific materials to be used on the project. This design will be performed by a laboratory which has experience in designing microsurfacing. After the mix design has been approved, no substitution will be permitted without prior approval.

ISSA can provide a list of laboratories experienced in microsurfacing design.

(b) MIX DESIGN

At least ten (10) days prior to placement the contractor shall submit to the Engineer for approval a complete mix design prepared and certified by a laboratory. Compatibility of the aggregate, polymer modified emulsion, mineral filler, and other additives shall be verified by the mix design. The mix design shall be made with the same aggregate gradation that the contractor will provide on the project. Recommended tests and values are as follows:

TEST	DESCRIPTION	SPEC.
ISSA TB-139	Wet Cohesion @	
	30 minutes min (set)	12 kg-cm min
	@60 minutes min. (traffic)	20 kg-cm min or near spin

ISSA TB-109	Excess Asphalt By LWT Sand Adhesion	50 g/ft^2 max (538 g/m^2 max)
ISSA TB-114	Wet Stripping	Pass (90%) min.
ISSA TB-100	Wet Track Abrasion Loss One Hour Soak Six Day Soak	50 g/ft^2 max (538 g/m^2) 75 g/ft^2 max (807 g/m^2)

The wet track abrasion tests are used to determine the minimum asphalt content and resistance to stripping. Some systems require longer times for the asphalt to adhere to the stone. In these systems a modified Marshall Stability Test (ISSA TB-140) or Hveem Cohesionmeter Test (ASTM D 1560) has been used to confirm asphalt content.

ISSA TB-147	Lateral Displacement	5% max.
	Specific Gravity After 1000 cycles of 125 lbs. (57 kg)	2.10 max.
ISSA TB-144	Classification Compatibility	(AAA, BAA) 11 grade points min.
ISSA TB-113	Mix Time @ 77º F (25º C)	Controllable to 120 sec. min.

The mixing test is used to predict how long the material can be mixed in the machines before it begins to break. It is more for information to be used by the contractor than for quality of the end product.

The mixing test and set time test should be checked at the highest temperatures expected during construction.

The mix design should report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). The report must clearly show the proportions of aggregate, mineral filler (min. and max.), water (min. and max.), additives usage, and polymer modified asphalt emulsion based on the dry weight of the aggregate.

All the component materials used in the mix design shall be representative of the materials proposed by the contractor to be used on the project.

The percentages of each individual material required shall be shown in the laboratory report. Adjustments may be required during construction, based on field conditions.

Residual Asphalt	5.5% to 10.5% (5) by dry weight of aggregate
Mineral Filler	0.0% to 3% by dry weight of aggregate
Polymer Based Modifier bitumen weight content.	Minimum of 3% solids based on
Additive	As needed
Water	As required to produce proper mix consistency

(c) RATE OF APPLICATION

The microsurfacing mixture shall be of the proper consistency at all times, so as to provide the application rate required by the surface condition. The average single application rate, as measured by the Engineer shall be in accordance with the following table:

Target Application Rate	
TYPE II Streets	15-30 pounds/yd^2 ($5.5 – 11$ kg/m^2)
TYPE III Wheel ruts	As required

Application rates are affected by the unit weight of the aggregate.

Microsurfacing is often put down in two full width passes in place of rut-filling when the rutting or deformation is not severe. When two passes are used the first pass (scratch course) is made using a metal strike off and applying only what the surface demands for leveling. The second course is applied at 15 – 30 lbs. per square yard ($5.5 – 11$ kg/m^2).

P-4 EQUIPMENT

(a) GENERAL

All equipment, tools and machines used in the performance of this work shall be maintained in satisfactory working condition at all times to ensure a high quality product.

(b) MIXING EQUIPMENT

The machine shall be specifically designed and manufactured to lay microsurfacing. The material shall be mixed by an automatic sequenced, self-propelled microsurfacing mixing machine, which shall be a continuous flow mixing unit, able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving multi-blade double shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls.

(c) PROPORTIONING DEVICES

Individual volume or weight controls for proportioning each material to be added to the mix (i.e. aggregate, mineral filler, emulsified asphalt, additive, and water) shall be provided and properly marked. These proportioning devices are used in material calibration and determining the material output at any time.

(d) SPREADING EQUIPMENT

The mixture shall be agitated and spread uniformly in the surfacing box by means of twin shafted paddles or spiral augers fixed in the spreader box. A front seal shall be provided to insure no loss of the mixture at the road contact point. The rear seal shall act as a final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry.

(e) SECONDARY STRIKE OFF

A secondary strike off shall be provided to improve surface texture. The secondary strike off shall have the same adjustments as the spreader box.

(f) RUT FILLING BOX

When required on the plans, before the final surface course is placed, preliminary microsurfacing material may be required to fill ruts, utility cuts, depressions, in the existing surface, etc. Ruts of ½ inch (12.7mm) or greater in depth shall be filled independently with a rut filling spreader box, either five foot (5') (1.52m) or six foot (6') (1.81m) in width. For irregular or shallow rutting of less than ½ inch (12.7mm) in depth, a full width scratch coat pass may be used as directed by the Engineer. Ruts that are in excess of 1-1/2 inches (39mm) in depth may require multiple placements with the rut filling spreader box to restore the cross section. **All rut filling level up material should cure under traffic for at least a twenty four (24) hour period before additional material is placed on top of the level up.**

(g) AUXILIARY EQUIPMENT

Suitable surface preparation equipment, traffic control equipment, hand tools, and any other support and safety equipment shall be provided by the contractor as necessary to perform the work.

P-5 CALIBRATION

Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Previous calibration documentation, covering the exact materials to be used may be acceptable, provided that no more than sixty (60) days have lapsed. The documentation shall include and individual calibration of each material at various settings, which can be related to the machine metering devices. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

P-6 WEATHER LIMITATIONS

Microsurfacing shall not be applied if either the pavement or air temperature is below 50º F (10º C) and falling, but may be applied when both pavement and air temperature are above 45º F (7º C) and rising. No microsurfacing shall be applied when there is the possibility that the finished product will freeze within twenty-four (24) hours. The mixture shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time.

P-7 SURFACE PREPARATION

Contractor shall prepare the streets according to Section N - Surface Preparation in its entirety before surfacing work can begin.

P-8 APPLICATION

(a) GENERAL

When required by local conditions, the surface shall be pre-wetted by fogging ahead of the spreader box. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity, and dryness of the pavement.

The microsurfacing shall be of the desired consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times to that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted.

No streaks, such as those caused by oversized aggregate, shall be left in the finished surface. If excess streaking develops, the job will be stopped until the contractor proves to the engineer that the situation has been corrected. Excessive streaking is defined as more than four drag marks greater the ½ inch wide (12.7 m) and or four inches long (100mm): or one inch wide (25.4mm) and 3 inches long (76.2mm) in any 27.3 sq. yd. (25sq.m.) area. No transverse ripples or longitudinal streaks of ¼ inches in depth (6mm)

will be permitted, when measured by placing a ten-foot (3m) straight edge over the surface.

(b) JOINTS

No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area. A maximum of three inches (76.2mm) shall be allowed for overlap of longitudinal lane line joints. Also the joint shall have no more than ¼ inch (6mm) difference in elevation when measured by placing a 10-foot (3m) straight edge over the joint and measuring the elevation drop off.

(c) MIX STABILITY

The microsurfacing shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. Under no circumstances shall water be sprayed directly into the laydown box, while laying microsurfacing material.

(d) HAND WORK

Areas which cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. If necessary, the area to be hand worked shall be lightly dampened prior to mix placement. Care shall be exercised to leave no unsightly appearance from handwork. The same type of finish as applied by the spreader box shall be required.

(e) LINES

Care shall be taken to ensure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide a good appearance. If necessary, a suitable material will be used to mask off the end of streets to provide straight lines. Edge lines shall not vary by more than ± 2 inches (± 50mm) horizontal variance in any 96 feet (30mm) of length.

(f) ROLLING

The entire area shall be rolled using a pneumatic tired roller. All rollers supplied shall comply with Section 39-5.02 of the State Standard Specifications. Rolling shall consist of three (3) complete coverages. Rolling shall commence after the surface has cured sufficiently so that the slurry seal will not adhere to the tires of the roller.

All rolling shall take place the day the mixture is placed. The roller shall at no time exceed 6 MPH while performing rolling operations.

(g) CLEAN UP

All areas, such as driveways, gutters, and intersections, shall have the microsurfacing mix removed as specified by the Engineer. The contractor shall, on a daily basis, remove any debris associated with the performance of the work.

(h) REPAIR OF EARLY DISTRESS

If bleeding, raveling, delamination, rutting, or washboarding occurs within 60-days after placing the microsurfacing, the Contractor shall make repairs by any method approved by the Engineer. The Contractor shall not be relieved from maintenance, and final contract payment will not be made, until repairs have been completed.

P-9 PAYMENT

Microsurfacing shall be paid for at the contract price per square foot, for Item 7, B3, C3, & D3, "Type II Microsurfacing". For all other Bid Items (No. 8 & A3) that this is used in combination with, the square foot measurements of the microsurfacing shall be the basis for payment for those combinations.

The contract price shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the slurry seal, complete in-place, as specified in these specifications and as directed by the Engineer **and no additional compensation shall be made therefore.**.

END OF SECTION

SECTION Q. PAVEMENT REINFORCING FABRIC

(COMBINATION BID ITEM'S NO. 6 & A3)

Q-1 GENERAL

Reinforcing Pavement Fabric shall be placed in those areas designated on the plans.

Unless otherwise stated in this section, all materials and placement shall conform to Sections 39-4 and 88 of the State of California, Department of Transportation Standard Specifications regarding pavement reinforcing fabric.

Q-2 PREPARATION

Contractor shall prepare the streets according to Section N - Surface Preparation in its entirety before surfacing work can begin.

Q-3 MATERIALS

The pavement reinforcing fabric shall be needle punched, non-woven, thermally bonded on one side, 100% polypropylene staple fiber fabric which conforms to the following:

Specification	Requirement
Tensile Strength, either direction, (lbs./kn), ASTM D-4632	101 minimum
Elongation at Break, either direction, (%), ASTM D-4632	50 minimum
Mullen Burst Strength, (PSI), ASTM D3786	180 minimum
Weight (oz/SY), ASTM D-3776	4.1 minimum
Asphalt Retention by Fabric (GSY)[O] ASTM D-6140	26.9 oz/SY residual minimum[O]

[O] Binder requirement increases as weight of fabric increases above 4.1 oz/SY*

Note: Weight, grab tensile, elongation and asphalt retention are based on Minimum Average Roll Value [MARV]

Q-4 EQUIPMENT

The equipment for placing the fabric shall be mechanized and capable of handling full rolls of fabric. The equipment used to place the fabric is subject to approval by the Engineer.

Pneumatic rollers used should be eight to ten tons and must have capabilities of applying a light oil parting agent directly on the rollers without overspray or dripping.

Q-5 PLACEMENT

Tack coat and fabric shall not be placed through intersections. The materials shall be held back 75 feet from the center of the intersection. All fabric and tack coat placement shall have clean and regular edges.

(a) TACK COAT/BINDER

The surface area to receive the fabric shall be sprayed with paving asphalt to be used as a binder. The binder shall be PG grade, 70-10. The application rate of paving asphalt, including overlaps, shall be a minimum of 0.28 +/-0.03 gal per square yard. The application rate of the tack coat needs to be sufficient to ensure the fabric is fully impregnated with bitumen (liquid paving asphalt), but not so heavy that there is free bitumen on the surface of the fabric. Application rate shall be increased in milled areas by 10% for smooth ground areas, 15% for large grooved areas. The Contractor shall determine the exact rate.

The Contractor's attention is directed to Section 92.1.03, "Applying Asphalt," of the State of California Standard Specifications. The asphalt binder shall be spread in the range of 290°F to 350°F.

Liquid asphalt application shall be placed on the pavement, two to four inches beyond all edges of the fabric where the fabric will not be lapped unless the additional width encroaches into the gutter pan.

(b) FABRIC

Paving fabric must be completely embedded in the liquid paving asphalt tack coat immediately after the tack coat is placed. It is imperative that broom pressure be applied uniformly across the full width of the fabric being placed. The fabric shall be placed with a minimum of wrinkles that lap. Large wrinkles (1" and larger) shall be slit and lapped in the direction of paving. Burning or torching of wrinkles will not be allowed. All wrinkles, bubbles and folds shall be removed by the Contractor to increase the bond between the fabric and the existing pavement. Where the integrity of the bond is lost, the fabric shall be removed and replaced at the discretion of the Engineer.

Transverse and longitudinal joints shall be butt joints and shall not overlap. Longitudinal joints shall be placed in the same location as travel lane delineation (striping).

Fabric shall be neatly cut approximately 6 inches back from the edge around manhole covers, valve boxes, survey markers, etc.

Fabric installation at cul-de-sacs shall be straight pulls from the back of the cul-de-sac and continuing through to the connecting street. Fabric shall not be placed on the bubble portion of the cul-de-sac.

Fabric placed in turn pockets should be installed on the turn pockets prior to placing the fabric on the adjacent travel lane. Fabric should be placed on turn pockets that measure six feet in width, or greater.

In areas with undulating curb lines, due to paving operation constraints and irregular pavement widths, fabric may be omitted at the curb line if the omitted portion is less than two feet.

If paved shoulders exist, fabric shall be placed on shoulders before placing fabric on travel lanes.

Under no circumstances shall traffic shall not be allowed on bare pavement reinforcing fabric.

Placement of oil and chip will occur immediately after fabric has been placed and rolled, with no more than 20 minutes elapsing.

Failure to place oil and chip within 20 minutes of placement of the fabric or allowing traffic on the exposed fabric, will result in the contractor removing all fabric, repairing any damage caused by the fabric removal, and beginning the process from the start.

(c) ROLLING

Rolling should begin immediately behind the fabric placement. Turning of the paving machine and rollers over the fabric must be gradual and kept to a minimum.

Rollers shall be pneumatic tired and should not exceed speeds of 5 mph during all passes. Sanding will not be permitted; as such, it is necessary to have a pneumatic tired roller with tire spray nozzles capable of applying a parting agent directly onto the tires without allowing liquid drips or runs onto the fabric surface.

Enough rolling has been done when the texture of the underlying pavement surface is visible on the surface of the fabric.

Q-6 PAYMENT

"Pavement Reinforcing Fabric" shall be paid as part of the combination Bid Item No. 6 & A3, and shall be considered full compensation for all labor, tools, equipment, and incidentals required to perform all work as specified herein and no additional compensation shall be made therefore.

END OF SECTION