USE OF POLYMER-MODIFIED EMULSIONS IN SEAL COATS

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In the Spring of 1982, the Texas Department of Highways and Public Transportation was approached by one of our emulsion suppliers who was promoting a cationic emulsion for chip seal work made with a polymer-modified asphalt. This material was reported to offer advantages of better rock retention and greater durability than ordinary asphalt. The material basically complied with our requirements for a CRS-2 except that the viscosity tended to be lower than our minimum specification limit and the penetration of the residue was in the range of 160 to 180.

The first use of this material was in June of 1982. It was used in placement of a seal coat on a section of State Highway 327 near Silsbee, which is in the southeast corner of the state. One transport of polymer-modified CRS-2 was used and the remainder of the project was placed with conventional CRS-2. No problems were encountered in placement. It was noted that the polymer-modified material required a little more time than standard CRS-2 to cure sufficiently to take traffic. Several of our Districts used trial amounts of the CRS-2 with polymer during the Summer and Fall of 1982.

The most popular anionic emulsion for seal coating in Texas has been high-float rapid-setting material. One of the emulsion manufacturers developed a high-float material from polymer-modified asphalt. The first use of this material was during the late Summer of 1983. One transport was used in placing a seal coat on Ranch Road 620 just west of Austin. The material performed satisfactorily except for the fact that the emulsion was quite low in viscosity--about 90 seconds, and since this roadway had considerable cross-slope at certain spots, the material ran to the low areas. The high-float rapid-setting material with polymer-modified residue also had a lower demulsibility than standard HFRS-2--in the range of 40.

The original material which we use on a trial basis and essentially all of the subsequent polymer-modified emulsion used in seal coat work is produced from an asphalt cement which has had styrene-butadiene block copolymer blended in with the hot AC.

Both the cationic and anionic versions of polymer-modified emulsion were used on a limited basis during 1983. During this time, the producers were able to overcome the problem of low viscosity and were able to supply a material complying with our standard viscosity range of 150 to 400 seconds. In the case of the CRS-2 with polymer, it was decided that a harder residue than that originally used was more desirable.

Our Fort Worth District used several loads of CRS-2P during the Fall of 1983 and were quite impressed with its performance. They made the decision to utilize CRS-2P in a large portion of their 1984 seal coat program. The material used during the spring performed well, but on a project which was begun in June, problems began to occur. The District personnel in charge of the seal coat program contacted us and said that the polymer-modified material was breaking and curing quite slowly--slower than conventional CRS-2. One section of roadway, which was opened to traffic after a longer than normal delay, much of the rock was whipped off or picked up by the traffic. We visited the project and observed the Contractor placing some of the CRS-2P and conventional CRS-2. We found that the CRS-2P was, indeed, slower to break and cure. An examination of the mat soon after placement of the rock showed that a skin or film was forming on the emulsion surface and trapping the water in the mat, thus retarding the cure. This phenomenon appeared to occur primarily in hot, dry weather. The emulsion supplier agreed that the material was curing much too slowly, and he tried a number of variations on the emulsion formulation, which included a higher than normal demulsibility to try and speed up break and a harder residue to try and increase toughness of the asphalt once the break and cure began. None of the variations tried helped significantly. A second emulsion supplier furnished some of their version of CRS-2P with essentially the same result.

It was concluded that the CRS-2P of the type available to us at present is not suitable for use in hot, dry weather.

Several of the Districts who had experimented with the anionic version, HFRS-2P, during 1983 were also impressed with its performance, and set up a number of projects for 1984 calling for this material.

The use of HFRS-2P during the 1984 construction season was generally quite successful. The HFRS-2P did not evidence the problem of slow break and cure in hot weather which had been experienced with the CRS-2P. A comparison of HFRS-2 and HFRS-2P showed that seals placed with HFRS-2P normally could be opened to traffic in a shorter period of time.

Several different special specifications were used to obtain the CRS-2P and HFRS-2P supplied during the 1984 construction season. We reviewed test data obtained on samples taken, discussed performance with our field personnel and prepared a specification for each material which we proposed to use during the 1985 season. We met with the two companies who supplied these materials during 1984 and discussed the specifications with them. They agreed with the requirements, and these specifications, copies of which are included in the appendix, went into effect in January of 1985. These are our current specifications for rapid-setting polymer-modified emulsions.

These specifications differ from those for standard rapid-setting emulsions in several ways. The standard distillation test was modified for the polymer materials in that the maximum temperature is 350 F. The total distillation time is 60 minutes. The purpose of this modification was to prevent damaging the polymer in the distillation operation.

The residue from the distillation test is distinguished from an ordinary asphalt by two requirements. A minimum ductility at 39.2 F (4C) and a maximum temperature susceptibility. The temperature susceptibility is described by a minimum penetration at 77 F and a minimum absolute viscosity at 140 F. There are two other differences in requirements between these and rapid-setting emulsions made with ordinary asphalt. One is the demulsibility requirement for the HFRS-2P material, which is a minimum of 40 percent, compared with 50 percent for an HFRS-2. The other is the penetration range for CRS-2P, which is 110 to 150, compared with 120 to 160 for CRS-2.

In November of 1985, we surveyed our Districts regarding their experience with CRS-2P or HFRS-2P. There were eight Districts who had used significant quantities of these materials. All are located in the eastern half of the state.

In sealing a roadway surface under normal conditions, the asphalt rate used for the polymer-modified materials was no different than for conventional emulsions. The aggregate rates were essentially the same. Because of the stickiness of the polymer-modified asphalt, some of the Districts increase the aggregate rate slightly--about five percent--to insure that the spreader and roller tires will not come in contact with the asphalt and cause picking up of the rock to occur. The aggregates used were either a nominal 5/8 inch size, which we designate as Grade 3, or a nominal 3/8 inch size, designated as Grade 4.

Points regarding performance of the polymer-modified materials on which there was general agreement were:

Advantages

1. More resistant to flushing or bleeding than ordinary emulsion. Good material to correct rich surfaces because you can get good initial stick of the rock with a lighter shot - seven Districts.

2. More resistance to rock loss in cold weather due to brittle fracture of the asphalt film - six Districts.

3. More resistant to whip-off of rock under initial traffic - four Districts.

One District used HFRS-2P to seal a large amount of cracked pavement. They indicated the polymer-modified residue kept the cracks sealed longer than conventional asphalt.

Limitations

1. CRS-2P is slow to cure in hot weather.

2. HFRS-2P cures at about the same rate or slightly faster than HFRS-2. It is subject to the same potential loss of aggregate as HFRS-2 if wet weather occurs immediately after placement.

The polymer-modified emulsions are not a cure-all. Insufficient embedment of aggregate in the polymer-modified asphalt can still result in rock loss in cold weather. However, several of our personnel pointed out that the polymer-modified residue is a more forgiving material--i.e., because of its properties, there is more latitude in asphalt application rates at which a successful seal coat can be obtained. The increased film strength and higher viscosity of the residue at elevated road temperatures and its greater flexibility at lower temperatures provides rock retention with a wider range of embedment than is possible with conventional asphalt.

The polymer-modified asphalt also provides a greater chance of success when sealing higher traffic roadways. An example of this is a seal coat placed by maintenance forces in August of 1985 on Loop 410 in the City of San Antonio. The wearing surface on the northwest portion of the Loop began to develop load-associated cracking and in order to prolong the life of the pavement, the decision was made to place a seal coat on an approximately three-mile section of this six-lane divided roadway. The section sealed extends from FM 1535 to Business Route 87 (Fredericksburg

Road). This roadway carries approximately 130,000 vehicles per day. The two inside lanes were sealed during the day on weekends, while the outside lanes were sealed at night. The seal placed during the day turned out to be an excellent job. The portion shot at night cured slower and some of the rock was whipped off by the initial traffic. Overall, the seal coat is performing quite well.

The amount of polymer-modified emulsion in relation to other emulsion use by the Texas Department of Highways and Public Transportation over the past two fiscal years is as follows:

	Gallons Used	
Type	Sept. 1983 through Aug. 1984	Sept. 1984 through Aug. 1985
CRS-2P	448,000	486,000
HFRS-2P	1,038,000	4,236,000
All Rapid-Setting Emulsions	17,274,000	25,830,000
Total Emulsion Use	30,594,000	42,312,000

We anticipate that the amount of polymer-modified emulsion used in seal coat work during 1986 will be equal to or slightly greater than the amount used in fiscal 1985. The specifications used will be those shown in the appendix.

The Districts who have worked with CRS-2P indicate it has given very good performance in cool weather. The use of CRS-2P will probably increase considerably if the problem of slow cure in hot weather can be overcome.

We have begun an evaluation of polymer-modified asphalts using force ductility equipment. We believe the information obtained from looking at various materials, including the residues from polymer-modified emulsions, will help us in determining the most desirable materials and also give us a better way to describe the materials in specifications.

APPENDIX

SPECIAL PROVISION

TO

ITEM 300

ASPHALTS, OILS AND EMULSIONS

For this project, Item 300, "Asphalts, Oils and Emulsions," of the Standard Specifications, is hereby amended with respect to clauses cited below and no other clauses or requirements of this Item are waived or changed hereby.

Article 300.2. Materials, Subarticle (6) Emulsions. The table of High Float Emulsions is supplemented by the following:

Type .... Rapid Setting
Grade HFRS-2P

Properties	Min	Max
Viscosity, Saybolt furol at 122 F, seconds	150	400
Storage Stability Test, one day, percent	-	1
Demulsibility, 35 cc of N/50, CaCl2, percent	40	-
Sieve Test, percent	-	0.10
*Distillation:		
Oil distillate, by volume of emulsion, percent	-	2
Residue, percent	65	-
Requirements on Residue from Distillation:		
Float Test at 140 F, seconds	1200	-
Penetration, 77 F, 100 g, 5 seconds	100	140
Ductility, 39.2 F, 5 cm/minute, cm	50	-
Solubility in trichloroethylene, percent	97.5	-
Viscosity at 140 F, Stokes	1500	-

*The standard distillation procedure shall be modified as follows:

The temperature on the lower thermometer shall be brought slowly to 350 ± 10 F and maintained at this point for 20 minutes. Complete the total distillation in 60 ± 5 minutes from the first application of heat.

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Article 300.2. Materials, Subarticle (6) Emulsions. The table of Cationic Emulsions is supplemented by the following:

Type .... Rapid Setting
Grade CRS-2P

Properties	Min	Max
Viscosity, Saybolt furol at 122 F, seconds	150	400
Storage Stability Test, one day, percent	-	1
Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate	40	-
Particle Charge Test	Positive	
Sieve Test, percent	-	0.10
*Distillation:		
Oil distillate, by volume of emulsion, percent	-	3
Residue, percent	65	-
Tests on Residue from Distillation:		
Penetration, 77 F, 100 g, 5 seconds	110	150
Viscosity, 140 F, stokes	1300	-
Ductility, 39.2 F, 5 cm/minute, cm	60	-
Solubility in trichloroethylene, percent	97.5	-

*The standard distillation procedure shall be modified as follows:

The temperature on the lower thermometer shall be brought slowly to 350 ± 10 F and maintained at this point for 20 minutes. Complete the total distillation in 60 ± 5 minutes from the first application of heat.