EVALUATION OF LATEX POLYMERS TO RESIST STRIPPING IN ASPHALT PAVEMENTS IN OREGON

Final Report

SPR 354

EVALUATION OF LATEX POLYMERS TO RESIST STRIPPING IN ASPHALT PAVEMENTS IN OREGON

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by

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16. Abstract

This study assessed the effectiveness of latex polymer anti-stripping treatment by inspecting and evaluating the condition of pavements constructed in Oregon from 1997-2001. Ten hot mix asphalt concrete paving projects were identified throughout the state. Five of the projects used hydrated lime as an anti-stripping additive, and five used latex polymer (UP-5000) as an anti-stripping additive. Each paving project that used UP-5000 as an anti-stripping additive was compared to a paving project that used hydrated lime as an additive. Both sites being compared shared similar aggregate sources.

Condition surveys were conducted on all of the sites, and in-service cores were taken from each project. The cores were tested using the AASHTO T 283 test method to determine the Tensile Strength Ratio (TSR). The TSR and condition ratings were used to assess the effectiveness of the UP-5000 compared to hydrated lime.

Based on the condition surveys, and the TSR testing, the UP-5000 was shown to be comparable to hydrated lime in preventing moisture induced distress in hot mix asphalt pavements in Oregon.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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EVALUATION OF LATEX POLYMERS TO RESIST STRIPPING IN ASPHALT PAVEMENTS IN OREGON

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1.0 INTRODUCTION

1.1 PROBLEM STATEMENT

Stripping of hot mix asphalt pavements has been a significant problem in Oregon. Prior to 2000, Oregon Department of Transportation (ODOT) policy required that aggregate be treated with hydrated lime for paving projects on some portions of I-5 and for most paving in Central and Eastern Oregon. Because of concerns expressed by some paving contractors about the health hazards of lime, the policy was revised in April 2000 to reduce the use of lime. The policy now mandates the use of lime treated aggregate only in the following areas:

- Interstates east of Troutdale, Oregon
- US 97 from Madras, Oregon to the Oregon/California border
- Cascade Mountain highways above 2500 ft (762 m) elevation with traffic levels above 3000 ADT or 1,000 trucks per day (two-way)

In 1997, ODOT began experimenting with the use of latex polymers to treat HMAC instead of hydrated lime. Because of the apparent success of early latex polymer treated projects the current ODOT policy allows for the use of latex polymer treated aggregates as an alternative to lime for paving projects in some of Oregon's highways, including the following:

- Interstate 5, MP 0-11 and MP 67-92
- Central and Eastern Oregon state highways (not covered under the mandatory hydrated lime requirements) with traffic levels above 1,500 ADT.

The paving contractor on projects meeting one of these two criterions may use either hydrated lime, or latex polymer treated aggregate. Since 1997 there have been several pavement sections in Oregon constructed using hydrated lime treated aggregates, and also sections with similar traffic and environmental conditions constructed with latex polymer treated aggregates.

Using latex polymers instead of hydrated lime is believed to reduce the health risks associated with hydrated lime around asphalt production plants. However, there is no quantitative or qualitative evidence about the effectiveness of latex polymers to resist stripping in Oregon specific asphalt concrete pavements.

1.2 OBJECTIVES AND RESEARCH METHODOLOGY

The objective of this study was to assess the effectiveness of HMA mixes that used latex polymer treated aggregates by comparing paving projects that used hydrated lime treated aggregates to those projects that used latex polymer treated aggregates. Recommendations could then be made about the future use of latex polymer treated aggregates and the potential for improving worker safety at HMAC plants.

The following tasks were undertaken in order to accomplish the research objectives:

1. A literature review was conducted to identify pavement inspection methods and test procedures appropriate for evaluating the stripping resistance of in-service pavements.

2. Identified pavement sections treated with latex polymers as well as equivalent lime treated sections.

3. Inspected each pavement section for evidence of stripping.

4. Extracted and tested cores using the methods identified in Task 1.

5. The data was analyzed to draw conclusions about the performance of each treatment type. Testing results were also compared with actual field performance and original project test data.

2.0 LITERATURE REVIEW

A literature review was conducted to identify pavement inspection methods and test procedures appropriate for evaluating the stripping resistance of in-service pavements.

Previous research focused primarily on determining the effectiveness of additives to reduce stripping, specifically hydrated lime. Laboratory studies have been conducted to evaluate latex polymers as an additive to reduce stripping. Little research has been conducted on the effectiveness of latex polymer additives compared to hydrated lime, in in-service pavements.

2.1 LABORATORY RESEARCH

Sebaaly and others (*1997*) evaluated the effectiveness of UP-5000 (a latex polymer additive) for use in HMAC mixtures. Laboratory mixtures were evaluated to compare the mixture properties of the UP-5000 system with lime treated and untreated mixtures. The authors used one binder for the evaluation and two different aggregate sources. To evaluate the moisture sensitivity of HMAC they used the moisture conditioning process as described by the AASHTO T-283 test method. The UP-5000 showed a noticeable increase in the absolute values of the dry and wet tensile strength. The laboratory testing also showed that UP-5000 was very effective in eliminating the moisture sensitivity of a severe stripping aggregate and significantly improved the performance of a marginal stripping aggregate. The authors concluded, based on the laboratory study, that the UP-5000 additive would produce HMAC mixtures that would have good resistance to moisture damage.

2.2 DISTRESS IDENTIFICATION

Moisture induced asphalt stripping can lead to several failures or distresses in the pavement. Sebaaly and others (*1997*) reported that moisture damage can manifest itself by several failure modes including rutting, fatigue, raveling, and low temperature cracking. Chong and others (*1975*) listed stripping as one cause of raveling and meandering cracks. Kandahl and Richards (*2001*) reported that typical signs of moisture induced stripping include the following: fines brought up to the surface by water, flushing of the surface, and potholing. Rutting of the pavement may also be present. Three stages of stripping were identified by Kandahl and Richards as: (1) fines or dust from partially stripped aggregates are on the surface, (2) a migration of asphalt binder to the road surface, or flushing, and (3) potholes in the flushed areas.

Based on the previous research about stripping induced distress the sites for this project were evaluated using the SHRP Distress Identification Manual (*1993*). Distress such as bleeding, cracking, rutting, and raveling were measured. The total area and severity of each distress was recorded using the methods described within the manual.

2.3 INFORMAL SURVEY

The Principal Investigators conducted an informal e-mail survey to evaluate the performance of UP-5000 in other states. Ultrapave, the company that produces UP-5000, identified twelve states that had used UP-5000 from 1996-2002: Alaska, Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oklahoma, Oregon, Texas and Washington. From the states that responded, Alaska, Texas, and Washington reported no stripping problems associated with mixes that used UP-5000. Nevada, California and Utah reported that they do not use UP-5000, based on laboratory tests that indicated that lime was more effective in reducing moisture damage.

3.0 SITE SELECTION

Because different aggregate types vary in their susceptibility to stripping, it was important to compare projects that used the same, or similar, aggregate sources. Due to this condition, it was extremely difficult to locate projects that used the same aggregate source, but produced pavements that were treated with both hydrated lime, and a latex polymer additive.

After an extensive search, a total of ten paving projects were identified that shared aggregate sources between a hydrated lime and a latex polymer treated asphalt concrete. After further analysis, two sites were removed from the study, leaving eight sites, or four paired comparisons. The projects selected for the research are shown in Table 3.1.

Table 3.1: Paving projects identified

Section Name	Year Paved	Route	Additive
Madras-Crooked River (SB Truck Scale)	1997	US 97	Latex
Madras-Crooked River (NB Truck Scale)	1997	US 97	Lime
Warm Springs Jct.-Pine Grove	1998	OR 26	Latex
Frog Lake-Warm Springs Jct.	2001	US 26	Lime
Enterprise Section	1999	OR 82	Latex
Enterprise-Lewiston & Wallowa Lake Highways	1998	OR82	Lime
Silvies River Br.-Jct US 395	1998	US 20	Latex
Hines-Silvies River	1998	US 20	Lime

Condition surveys were conducted on the identified projects during the summer of 2002, based on the SHRP Distress Identification Manual (*1993*). Distresses such as cracking, bleeding, raveling, rutting, and shoving which are attributed to stripping were considered. Very little distress was found at any of the sites.

3.1 MATERIALS COLLECTION

The AASHTO T-283 test to determine the Tensile Strength Ratio (TSR) was chosen to evaluate the stripping potential of the HMAC pavements. The test calls for 4 in (101.6 mm) diameter cores to be taken from the pavement. At each project site, eight cores were taken. The cores were cut with a 4 in (101.6 mm) water cooled diamond drill bit, patted surface dry and then placed in plastic bags for shipment to the ODOT Materials Laboratory in Salem, Oregon.

The cores were taken from the right wheel path, center of lane and left wheel path as shown in Figure 3.1. Six of the cores were used to determine the TSR, while the remaining two cores were used to determine the maximum specific gravity, which is part of the AASHTO T283 test.

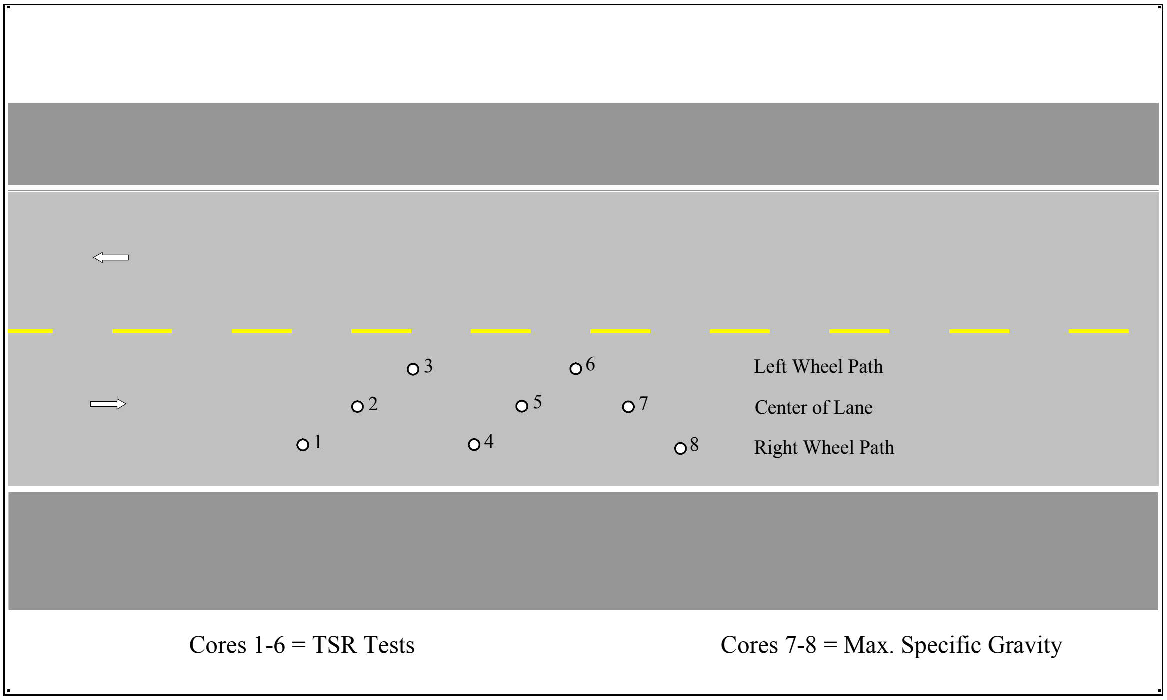

Figure 3.1: Typical coring plan

4.0 TESTING AND ANALYSIS

At each location, in-place cores were taken and then tested to determine the TSR. The TSR and the condition survey results were used to compare the performance of HMAC treated with latex polymers to HMAC treated with hydrated lime.

The following sections give descriptions of each test site, the climate, results of the condition surveys, and the results of the AASHTO T-283 tests. For some of the projects, contractor test data from the time of construction is also presented.

4.1 ENTERPRISE, OREGON

Both of these sites are located near Enterprise, Oregon. The annual precipitation is 19.67 in (49.96 cm), the average high temperature is 60.4°F (15.78°C), and the average low temperature is 29.9°F (-1.17°C).

4.1.1 Enterprise – Lewiston & Wallowa Lake Highway's

This project is on Oregon Route 82 (ODOT Highway 10) between mile points 62.5-64.5. The AADT at this location is 2700 vehicles. The asphalt concrete was placed in 1998 and was an Oregon standard duty, lime treated class "B" HMAC. The mix design called for 1% hydrated lime and it used aggregate from ODOT Source # 32-016-5, Enterprise Quarry. The results of a 2002 condition survey are shown in Table 4.1.

Table 4.1: Enterprise-Lewiston condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
182L	0.03	223

Eight 4 in (10.16 cm) diameter cores were taken at MP 63.0 on November 21, 2002. The test results of the cores, and contractor lab test data from 1998 when the section was constructed is shown in Table 4.2.

Table 4.2: Enterprise-Lewiston test results

Location	G_{mm}	Average Air Voids	TSR	Average Thickness	
				(in)	(cm)
MP 63.0	2.620	4.5%	85%	2.28	5.79
Contractor	2.605	6.4%	77%	-	-

4.1.2 Enterprise Section

Also on Oregon Route 82 (ODOT Highway 10), this project is located in downtown Enterprise, between mile points 64.54-65.65. The AADT at this location is 5600. The asphalt concrete was placed in 1999 and was an Oregon standard duty, class "C" HMAC. The mix design called for 0.05% UP-5000 and it used aggregate from ODOT Source # 32-016-5, Enterprise Quarry. The results of a 2002 condition survey are shown in Table 4.3.

Table 4.3: Enterprise Section condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
293L	0.03	298

Eight 4 in (10.16 cm) cores were taken at MP 64.72 on November 21, 2002. The test results of the cores are shown in Table 4.4. Contractor test data from 1999 was not available.

Table 4.4: Enterprise Section test results

Location	G_{mm}	Average Air Voids	TSR	Average Thickness	
				(in)	(cm)
MP 64.72	2.564	1.9%	93%	2.53	6.43

4.1.3 Summary

The HMAC used in both projects is performing very well, with little distress observed. TSR values were above the minimum of 80. The Enterprise section did have a higher TSR, but the distress levels of both sections were minimal.

4.2 BURNS, OREGON

Both of these sites are located near Burns, Oregon. The annual precipitation is 10.96 in (27.84 cm), the average high temperature is 59.6°F (15.34°C), and the average low temperature is 32.8°F (0.45°C).

4.2.1 Hines – Silvies River

This project is located west of Hines, Oregon on US Highway 20 (ODOT Highway 7) between mile points 128.25-132.51. The AADT at this location is 3600 vehicles. The asphalt concrete was placed in 1998 and was an Oregon standard duty, lime treated class "C" HMAC. The mix design called for 1% hydrated lime and it used aggregate from ODOT Source # 13-074-5, 5 Mile Dam Quarry. The results of a 2002 condition survey are shown in Table 4.5.

Table 4.5: Hines – Silvies River condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
157L	0.02	554

Eight 4 in (10.16 cm) diameter cores were taken at MP 128.35 on November 19, 2002. The test results of the cores, and contractor lab test data from 1998 when the section was constructed are shown in Table 4.6.

Table 4.6: Hines-Silvies River test results

Location		G_{mm}	Average Air Voids	TSR	Average Thickness	
					(in)	(cm)
MP 128.35		2.491	1.6%	84%	1.73	4.4
Contractor	Lot 1	2.501	7.5%	99%	-	-
	Lot 2	2.501	7.3%	105%	-	-

4.2.2 Silvies River Br. – Jct US 395

The majority of this project is east of Burns, Oregon on US 20 (ODOT Highway 7) between mile points 132.51-134.32, there was also some paving done through downtown Burns. For this research project, only the section from Monroe Street to "B" Street on US 20 was considered, the remainder of the project was a different mix. The asphalt concrete placed in 1998 through downtown Burns, was an Oregon standard duty, class "B" HMAC. The mix design called for 0.013% UP-5000 and it used aggregate from ODOT Source # 13-009-5, Hebner Quarry. The results of a 2002 condition survey are shown in Table 4.7.

Table 4.7: Silvies River Br. – Jct US 395 condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
130L	0.01	460

Eight 4 in (10.16 cm) diameter cores were taken at MP 131.6, between Madison and Adams Street, on May 1, 2003. The test results of the cores are shown in Table 4.8.

Table 4.8: Silvies River Br.-Jct US 395 test results

Location	G_{mm}	Average Air Voids	TSR	Average Thickness	
				(in)	(cm)
MP 131.6	2.510	4.8%	90%	2.29	5.82

4.2.3 Summary

The two sections comparatively are very similar. The distress at both locations was minimal, and the results of the core testing showed the TSR values at 99 and 90, well above the minimum of 80. There seemed to be little difference based on performance between the HMAC that used latex and the HMAC that used hydrated lime.

4.3 WARM SPRINGS JCT.

These two sites are located near the Warm Springs Junction of US 26 and OR 216. Annual climate information was not available for this location.

4.3.1 Warm Springs Jct – Pine Grove

This project is on Oregon Route 216 (ODOT Highway 44) between mile points 0.18-12.63. The AADT at this location is 380 vehicles. The asphalt concrete was placed in 1998 and was an Oregon standard duty, class "B" HMAC. The mix design called for 0.025% UP-5000 and it used aggregate from ODOT Source # 33-080-4, Dodge Quarry. The results of a 2002 condition survey are shown in Table 4.9.

Table 4.9: Warm Springs Jct – Pine Grove condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
206L	0.01	0

Eight 4 in (10.16 cm) diameter cores were taken at MP 6.75 on October 17, 2002. The test results of the cores and contractor lab test data from 1998 when the section was constructed are shown in Table 4.10.

Table 4.10: Warm Springs Jct – Pine Grove test results

Location	G_{mm}	Average Air Voids	TSR	Average Thickness	
				(in)	(cm)
MP 6.75	2.550	6.1%	101%	1.58	4.01
Contractor	2.542	7.15%	104%	-	-

4.3.2 Frog Lake – Warm Springs Jct

This project is on US Highway 26 (ODOT Highway 53) between mile points 62.0-71.0. The AADT at this location is 5100 vehicles. The asphalt concrete was placed in 2001 and was an Oregon level 3, 12.5 mm dense mix, with 1% hydrated lime. The aggregate used was from ODOT Source # 33-080-4, Dodge Quarry. The results of a 2002 condition survey are shown in Table 4.11.

Table 4.11: Frog Lake – Warm Spring Jct condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
27L	0	0

Two sets of eight cores were taken on October 17, 2002 at two different locations on this project, one at MP 62.1 and a second set at MP 70.0. The test results for both sets of cores, and contractor test results from the time of construction are shown in Table 4.12.

Table 4.12: Frog Lake – Warm Spring Jct test results

Location	G_{mm}	Average Air Voids	TSR	Average Thickness	
				(in)	(cm)
MP 62.1	2.550	5.0%	86%	1.155	2.94
MP 70.0	2.544	4.4%	117%	1.355	3.44
Contractor	2.520	6.52%	94.5%	-	-

4.3.3 Summary

Both sections are performing well, the TSR for both sections were above the 80% minimum, and two out of the three sets were above 100%. Based on distress, both sections were performing well, with minimal amounts of raveling present. It should be noted that the Frog Lake – Warm Springs Jct section was placed in 2001, while the Warm Springs Jct – Pine Grove section was placed in 1998. There seems to be little difference in the performance of the two different sections.

4.4 MADRAS WEIGH STATIONS

Both of the following sites were constructed under the 1997 Crooked River – Madras project. The sections of the project considered for this research are two ODOT Motor Carrier enforcement truck scales located south of Madras, Oregon, adjacent to U.S. Highway 97. The annual precipitation for the area is 11 in (27.94 cm), the average high temperature is 57°F (13.89°C), and the average low temperature is 39°F (3.89°C).

The two weigh stations were included in a 1997 demonstration to compare the performance of hydrated lime to UP-5000. The northbound scale was constructed with 1% hydrated lime, and the southbound scale was constructed with 0.025% UP-5000.

4.4.1 Madras Southbound Scale

The scale is located adjacent to US Highway 97 (ODOT Highway 4) at mile point 108.1, on the southbound side of the highway. The asphalt concrete was placed in 1997 and was an Oregon standard duty, "B" HMAC. The mix design called for 1% hydrated lime, but 0.025% UP-5000 was substituted in place of the lime. The aggregate used was from ODOT Source # 16-012-4, McPheeter's Quarry. A condition survey was conducted in 2002 on the pavement around the scale. Results are shown in Table 4.13.

Table 4.13: Madras Southbound Scale condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
200L	0.01	0

Four different sets of eight cores were taken from the scale approach area. Three sets were taken from the "bypass lane" of the scale, and one set of cores were taken from the lane directly approaching the scale. The lab test results of all four sets of cores are shown in Table 4.14. Both lanes showed relatively low distress except for the area directly prior to the scale. This area was heavily distressed, including rutting, shoving, and bleeding. Figure 4.1 shows the approach to the scale. The exit lane from the scale showed little distress, similar to the surrounding pavement.

Table 4.14: Madras Southbound Scale – core test results

Coring Location/Date		**Bypass Lane 1 11/14/02**	**Bypass Lane 2 11/24/03**	**Bypass Lane 3 11/24/03**	**Travel Lane 11/24/03**
Gmm		2.521	2.517	2.513	2.505
Average Air Voids		6.3	5.4	4.7	1.8
TSR		74%	107%	104%	106%
Average Thickness	**(in)**	1.69	1.91	1.93	1.94
	(cm)	4.29	4.85	4.90	4.92

Figure 4.1: Madras SB Weigh Station – rutting in approach lane

Three sets of cores were taken from the bypass lane, one set in 2002 and the remaining two sets in 2003. The 2003 cores were taken to assess the repeatability of the AASHTO T283 test method. It would be assumed that cores taken from a given site would have similar results. However, the TSR for the 2002 cores was 74%, while the 2003 cores had a TSR of 107% and 104%. Upon examining the individual tensile strength results for the cores from the 2002 set, it was noticed that one of the conditioned cores had a tensile strength of over half of the other two cores. Neither, the air void level, or the saturation level indicated anything different about the core. However, a visual examination of the core prior to testing revealed that the core showed signs of too little asphalt.

The results from the two other cores in this particular set (one conditioned and one unconditioned) were discarded from the TSR calculation. They were apparently discarded because their air void levels were not within the normal 6.0 to 8.0% range required for lab compacted samples. However, the AASHTO T283 test does not require cores to be within these limits. If the very low strength core is discarded as an outlier, and the results for the two cores originally discarded are included, the TSR recalculates to 103. This fits very well with the data from the 2003 cores and provides an average TSR of 105 for the three sets, with a standard deviation of only 3.

4.4.2 Madras Northbound Scale

The scale is located adjacent to US Highway 97 (ODOT Highway 4) at mile point 106.8, on the northbound side of the highway. The asphalt concrete was placed in 1997 and was an Oregon standard duty, lime treated class “B” HMAC. The mix design called for 1% hydrated lime and it used aggregate from ODOT Source # 16-012-4, McPheeter’s Quarry. In 2002, a condition survey was conducted on the pavement around the scale. The results are shown in Table 4.15.

Table 4.15: Madras Northbound Scale condition survey results

Average per 500 ft Section		
Raveling SQ. FT./Severity	**Rutting FT.**	**Bleeding SQ. FT**
240L/100M	0.005	20

Four different sets of eight cores were taken from the scale approach area. Three sets were taken from the “bypass lane” of the scale, and one set of cores were taken from the lane directly approaching the scale. The bypass lane showed relatively low distress. However, the travel lane (approach to the scale) did have an area of slightly higher distress, including a small area of rutting just prior to the scale. The lab test results for all four sets of cores are shown in Table 4.16.

Table 4.16: Madras Northbound Scale – core test results

Coring Location/Date		Bypass Lane 1 11/14/02	Bypass Lane 2 11/24/03	Bypass Lane 3 11/24/03	Travel Lane 11/24/03
Gmm		2.558	2.526	2.528	2.540
Average Air Voids		6.9	5.6	6.2	4.0
TSR		82%	96%	117%	107%
Average Thickness	**(in)**	1.58	1.93	1.95	1.97
	(cm)	4.01	1.90	4.95	5.00

Three sets of cores were taken from the bypass lane, one in 2002 and the remaining two in 2003. The 2003 cores were taken to assess the repeatability of the AASHTO T283 test method. The TSR for the 2002 set of cores was 82, while the 2003 sets were 96 and 116. The range of test results was puzzling, as the 2003 cores were taken at the same locations as the 2002 cores. Examination of the individual core results yielded no significant differences in air voids, saturation levels, or tensile strengths. Because no clear reason for the differences in TSR values was evident, the results were accepted. The average TSR for the three sets of cores was 98, with a standard deviation of 17. The TSR method does have a reputation for high variability and these three sets may be demonstrating that.

4.4.3 Summary

Overall, the average air voids of all 18 cores taken from the southbound site were 5.3%, while it was 6.2% for the northbound site. The lower air voids in the southbound cores may explain why the conditioned specimens from each southbound set did so well against the unconditioned specimens resulting in high TSR numbers. However, the northbound cores had excellent results even if they were lower than the southbound sites. Both sites have performed well, regardless of the anti-stripping additive used, latex or lime.

5.0 RESULTS AND RECOMMENDATIONS

ODOT has a standard for using hydrated lime as an anti-stripping additive in HMAC. In 1997, ODOT began using latex polymers, as an anti-stripping additive to treat aggregate, instead of hydrated lime in some areas of the state. However, there is no evidence about the effectiveness of using latex polymers as an anti-stripping additive in Oregon. This study compared HMAC mixtures that were constructed with like aggregates, and used hydrated lime or latex polymers as an anti-stripping additive.

Eight projects, or four comparisons, were identified and tested for this study. The sections ranged in age from one to five years since construction. None of the sections showed signs of stripping during the condition surveys, or after the TSR testing. The TSR test was used to measure the susceptibility of the HMAC to moisture damage. The TSR values were then used to help compare the test sections. Table 5.1 shows the TSR test results, and the condition survey results for all eight sites.

Table 5.1: TSR and condition survey results for all eight sites

Section	Additive	TSR (%)	Average per 500 ft. Section		
			Raveling ft^2	**Rutting ft**	**Bleeding ft^2**
Silvies River Br.-Jct US 395	Latex	90	130L	0.01	460
Hines – Silvies River	Lime	84	157L	0.02	554
Madras Weigh Station SB--Bypass Lane	Latex	74	200L	0.01	0
	Latex	107			
	Latex	104			
Madras Weigh Station SB--Travel Lane	Latex	106			
Madras Weigh Station NB--Bypass Lane	Lime	82	240L/ 100M	0.005	20
	Lime	96			
	Lime	117			
Madras Weight Station NB--Travel Lane	Lime	107			
Warm Springs Jct – Pine Grove	Latex	101	206L	0.01	0
Frog Lake – Warm Springs Jct.	Lime	86	27L	0	0
	Lime	117	27L	0	0
Enterprise	Latex	93	293L	0.03	298
Enterprise - Lewiston & Wallowa Lake Highway's	Lime	85	182L	0.03	223

After analysis, the data showed little difference in the performance to date between the sections that used hydrated lime or latex polymers.

5.1 RECOMMENDATIONS

Based on the results of this study, the current policy of allowing latex polymers (as on option to lime) as an anti-stripping additive in some areas is valid. However, until more long term information is available, keeping the current policy of lime only on some sections of Interstates, U.S. Highway 97 and Cascade Mountain highways, is a viable policy.

Based on the outcome of this study, the topic of using latex polymers to resist stripping should be revisited after the pavements have been in-service for a longer period of time.

6.0 REFERENCES

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