16 State House Station
Augusta, Maine 04333

MaineDOT

Transportation Research Division

Technical Report 17- 07

Experimental Demonstration of Liquid Anti-strip in Hot Mix Asphalt Pavement

Final Report, April 2017

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Transportation Research Division

Experimental Demonstration of Liquid Anti-strip in Hot Mix Asphalt Pavement

Introduction

In 2010, the Maine Department of Transportation constructed two projects with the use of Liquid Anti-strip. The intent of these projects is to determine if an anti-strip admixture will improve the pavement quality in Northern Maine as well as other areas.

In recent years, the Department has noticed many areas, particularly in Northern Maine, experiencing loss of aggregate in the wheel paths on recently placed HMA. This project has been selected due to its close proximity to other previously constructed projects that have exhibited premature failure and durability issues, most generally raveling and loss of aggregate from the wearing course. It has generally been accepted that the use of ant-strip additives was not a requirement when using virgin aggregate mixtures, but there is evidence from other State and Canadian Province studies that indicate that moisture damage and aggregate stripping incidence increases proportionally with the increase in recycled asphalt (RAP) percentages. This study is being conducted to determine which criteria determines liquid anti-strip use, and if anti-strips will be required.

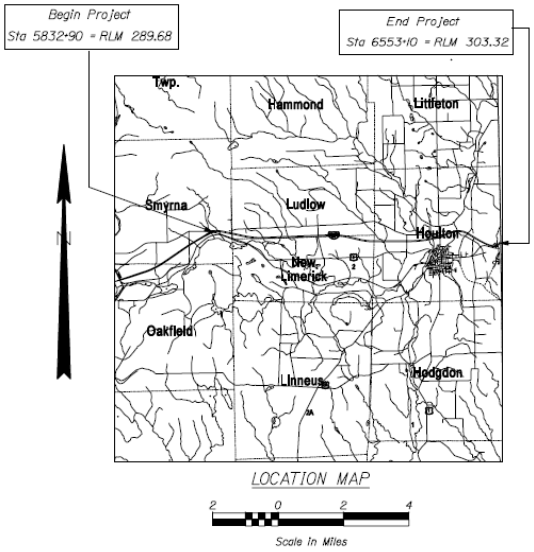
The occurrence of aggregate raveling and stripping is not isolated to Region 5, but is also evident in other parts of the state. This indicates that the issue may be related to not only aggregate sources, but RAP quality and percentages.

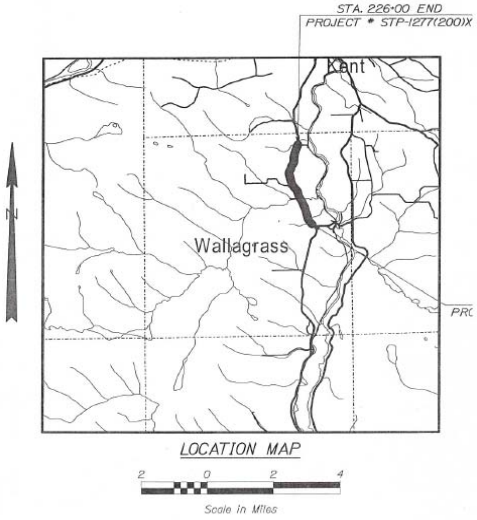
As previously stated, liquid anti-strip has been used extensively by our Canadian neighbors in New Brunswick. Their aggregates are very similar in nature to those in Northern Maine as well as similar climatic conditions. They have been using this admixture for approximately 10 years. Irving Oil, as well as All States Asphalts, supply this material. Thus, material availability is not an issue. Anticipated added costs for this material to be incorporated in our Hot Mix Asphalt is estimated to be in the range of $1 to $2/HMA ton.

Project Location

The Department identified the Smyrna to Houlton project as one of the pilots, PIN 16819.10; IM-1681(910)S. This project is a 13.64 miles stretch of I-95 Northbound. It is the northern most section of I-95 in the state. For the purposes of this report, this project will be referred to as Houlton I-95NB.

The other pilot project is Wallagrass Rt. 11, PIN 12772.00; STP-1277(200)X. This project is a 2.4 mile highway reconstruction beginning approximately 0.5 miles north of the Soldier Pond Road. The maps below show the projects locations.





Project Scope

Houlton-Smyrna I-95 NB is a mill and fill hot mix asphalt overlay. A 9.5mm nominal maximum aggregate size (NMAS) hot mix asphalt shim was placed to a 0.75" thickness followed by a 12.5 mm NMAS hot mix asphalt wearing course placed to 1 ½" thickness. The entire project length used the liquid anti-strip additive with the exception of the last ½ mile, Station 6440+30 to 6464+34. This will be used for the control section.

Wallagrass Rt. 11 is a highway reconstruction with dense graded crushed aggregate subbase, plant mix recycled asphalt pavement base, a 1 ¾" HMA base, a ¾" shim and a 1 ½" HMA wearing course. The wearing course is a 12.5 mm NMAS, Item 403.208. Only the wearing course for the entire project length used the liquid anti-strip additive with the exception of the last 0.70 miles, Station 215+00 to Station 226+00 RT. This will be used for the control section.

Construction

The anti-strip was added to the liquid PG binder at the terminal as each tanker truck was loaded; this is a very accurate metering process. Irving Oil Commercial GP and Down East Emulsions, LLC have supplied the binder for respectively Smyrna and Wallagrass.

The construction and paving operations were completed as planned. There were no notable problems encountered in placing the pavement layers that would impact this evaluation.

The ARAN data have been collected every year for Houlton I-95 NB and every other year on Wallagrass Rt. 11 since 2001.

Project Monitoring and Performance Evaluation

Both projects have been observed for performance over a five years period after the construction. No construction and interim report has been drafted, so the present report will be the sole report summarizing the findings since construction and covering five years post construction. Therefore this final report includes six years of data collected from the Department ARAN for the interstate project (2010 to 2015) and three years of data for the second project. Because the data collection on non-interstate routes is done every other year, no data was collected during the year of construction on route 11 for the second project. Table 1 below shows the portions of the projects that have been collected by the ARAN for performance comparison of both control and test sections.

<table>
<tr><th></th><th colspan="3">I95 - Smyrna - WIN 016819.10</th><th colspan="3">Route 11 - Wallagrass - WIN 012772.00</th></tr>
<tr><th></th><th>Begin Station</th><th>End Station</th><th>Wearing Course</th><th>Begin Station</th><th>End Station</th><th>Wearing Course</th></tr>
<tr><td rowspan="2">Test Section</td><td>Station 5744+00 (Right)</td><td>Station 6440+30 (Right)</td><td rowspan="2">1.5" lift

12.5 mm HMA with liquid anti-strip</td><td rowspan="2">Station 100+00 (Right)</td><td rowspan="2">Station 215+00 (Right)</td><td rowspan="2">1.5" lift

12.5 mm HMA with liquid anti-strip</td></tr>
<tr><td>Station 6464+34 (Right)</td><td>Station 6556+47 (Right)</td></tr>
<tr><td>Control Section</td><td>Station 6440+30 (Right)</td><td>Station 6464+34 (Right)</td><td>1.5" lift 12.5 mm HMA</td><td>Station 215+00 (Right Only)</td><td>Station 226+00 (Right Only)</td><td>1.5" lift 12.5 mm HMA</td></tr>
</table>

Table 1 – Test and Control Sections

In order to evaluate the performance of both treatments, the data collected were analyzed over the period of time of data collection 2009 to 2015 in both sections: Test Section with liquid anti-strip and Control Section without liquid anti-strip.

The tables 2 & 3 below give the ride, rut and pavement condition measurements based on Automatic Road Analyzer (ARAN) network collection over times for both projects.

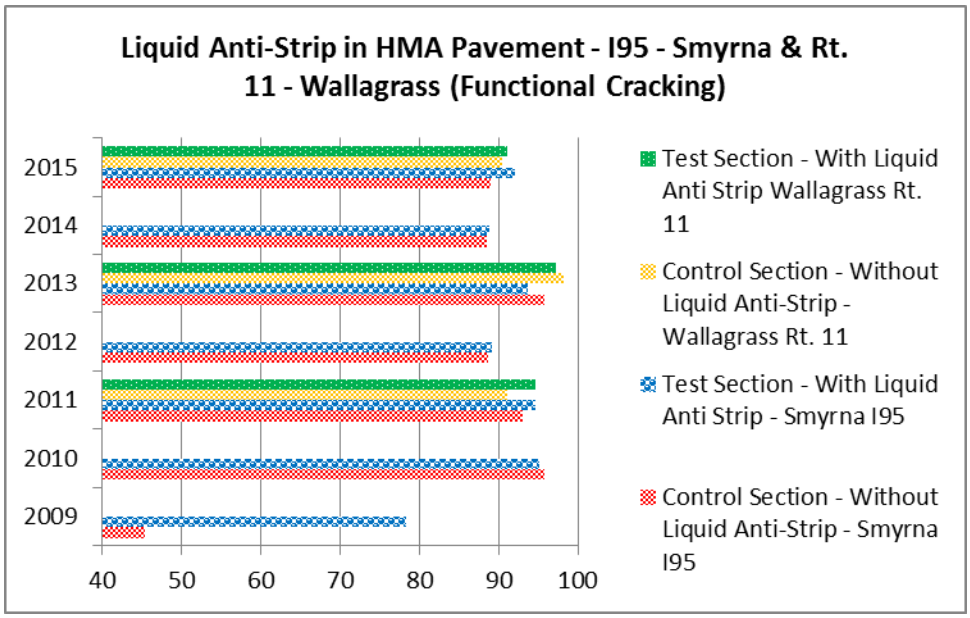
	IRI (in/mile)	Rut Depth Left Wheel Path (inches)	Rut Depth Right Wheel Path (inches)	Pavement Condition Rating (PCR)
Pre-Paving (2009)				
Control Section	**114.1**	**0.26**	**0.38**	2.70
Test Section	**80.2**	**0.33**	**0.34**	3.61
Year of Paving (2010)				
Control Section	**49.3**	**0.01**	**0.04**	4.71
Test Section	**38.0**	**0.02**	**0.06**	4.71
Post-Paving One Year (2011)				
Control Section	**51.2**	**0.05**	**0.10**	4.60
Test Section	**36.4**	**0.08**	**0.14**	4.58
Two Years (2012)				
Control Section	**52.6**	**0.09**	**0.18**	4.34
Test Section	**38.7**	**0.15**	**0.2**	4.29
Three Years (2013)				
Control Section	**54.5**	**0.13**	**0.20**	4.42
Test Section	**40.5**	**0.18**	**0.26**	4.26
Four Years (2014)				
Control Section	**61.8**	**0.16**	**0.22**	4.22
Test Section	**43.9**	**0.23**	**0.31**	4.06
Five Years (2015)				
Control Section	**66.1**	**0.18**	**0.25**	4.19
Test Section	**48.7**	**0.20**	**0.35**	4.09

Table 2 – Ride, Rut, and PCR Ratings – Smyrna I-95

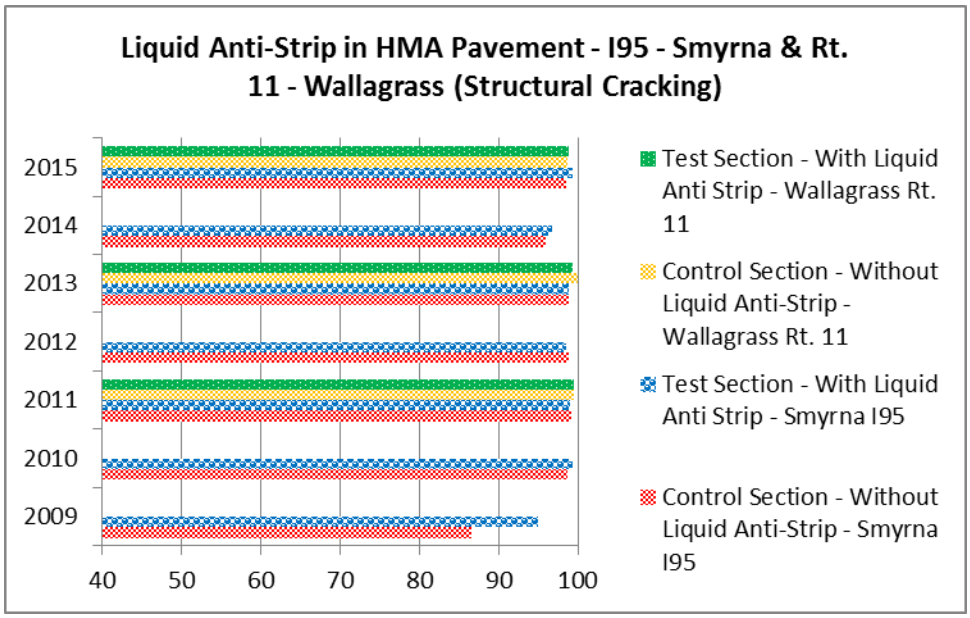
	IRI (in/mile)	Rut Depth Left Wheel Path (inches)	Rut Depth Right Wheel Path (inches)	Pavement Condition Rating (PCR)
Post-Paving				
One Year (2011)				
Control Section	**60.4**	**0.06**	**0.16**	4.40
Test Section	**60.4**	**0.05**	**0.13**	4.55
Three Years (2013)				
Control Section	**70.0**	**0.14**	**0.32**	4.24
Test Section	**78.7**	**0.12**	**0.27**	4.23
Five Years (2015)				
Control Section	**130.8**	**0.24**	**0.34**	3.65
Test Section	**128.7**	**0.21**	**0.29**	3.75

Table 3 – Ride, Rut, and PCR Ratings – Wallagrass Route 11

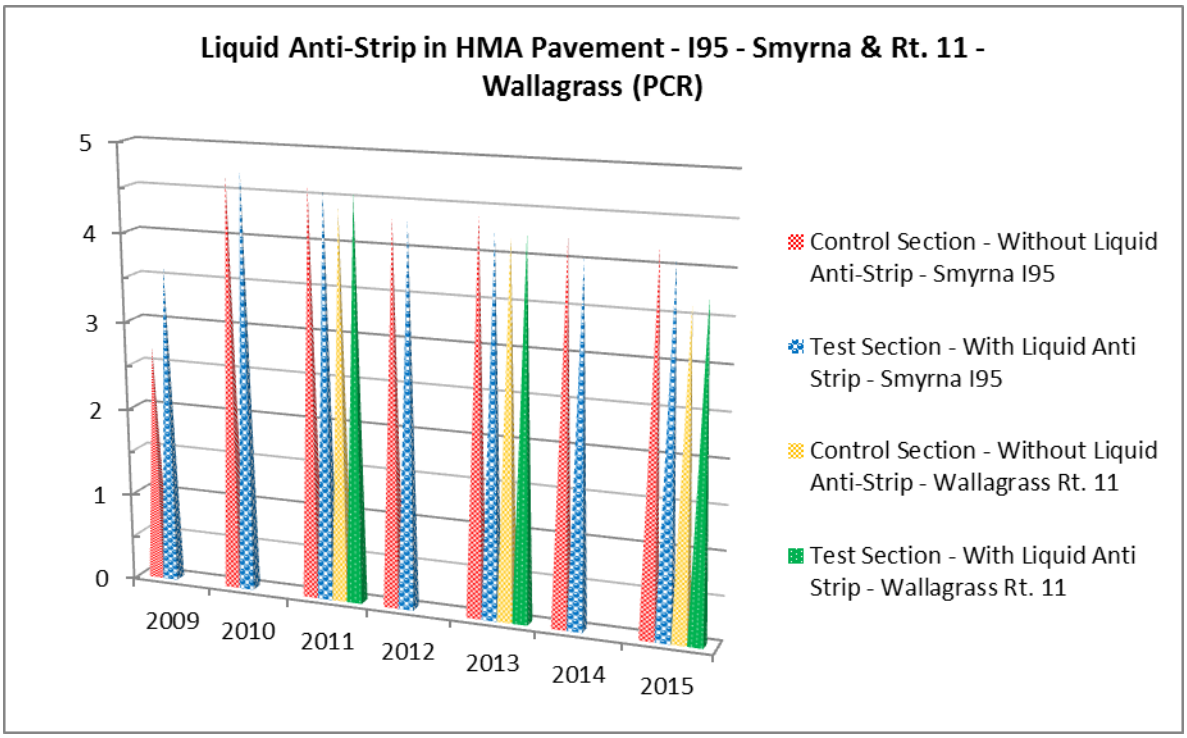
The graphs below show variation of functional and structural cracking given in Index values as well as PCR variation based on the data of Automatic Road Analyzer (ARAN) network collection data for both projects, knowing that the data have been collected every year on interstates and every other year on non-interstate roads.



Graph 1 – Functional Cracking Index variation



Graph 2 – Structural Cracking Index variation



Graph 3 - PCR variation

Interpretation of the data

- Smyrna – I-95 NB – 016819.10

The data collected one year prior to the paving operation indicate that the test section was in a better shape than the control section. The PCR values are 3.6 and 2.7 respectively for the test section and the control section. The post paving condition, unlike the pre-paving, shows that the control section has performed slightly better than the test section. This unexpected finding is most likely due the fact that more rutting were noticed over the years in the test section, while the control section indicates more roughness. Both sections have degraded nearly the same way regarding the cracking. Overall the PCR of both sections decreased from 4.71 in 2010 to 4.19 and 4.09 in 2015 respectively for the control section and the test section.

- Wallagrass – Rt. 11 – 012772.00

The data collected for this project show that the test section has a better performance than the control section. Indeed, less roughness and rutting as well as cracking have been noticed in the test section compared to the control section. The PCR values calculated for both sections vary respectively for the test and control sections from 4.55 in 2011 to 3.75 in 2015 and from 4.40 to 3.65.

It is important however to point out that the department acquired a new ARAN vehicle that started collecting data in 2016 with change and improvement in the software used to treat the raw data. Thus, new software is being implemented and has been used to get the values of the pavement conditions parameters as well as the PCR beginning by 2015 data. Therefore the 2015 values should be treated with caution, knowing that more data is needed to confirm the trend and the new software implementation.

t-Test

Because we found a slight difference in the variation of the PCR of both treatments for both projects, we performed a t-Test to check whether or not the difference is statistically significant for each case. The t-Test used for this verification is the t-Test: Two-Sample Assuming Equal Variance because we have the same number of data points coming from two different populations.

t-Test: Two-Sample Assuming Equal Variances

- Smyrna – I-95 NB – 016819.10

	Control Section	*Test Section*
Mean	4.413666667	4.333502798
Variance	0.042911467	0.068650206
Observations	6	6
Pooled Variance	0.055780836	
Hypothesized Mean Difference	0	
df	10	
t Stat	0.587890961	
P(T<=t) one-tail	0.284821334	
t Critical one-tail	1.812461123	
P(T<=t) two-tail	0.569642668	
t Critical two-tail	2.228138852	

Table 4 – t-Test – Smyrna I-95

- Wallagrass – Rt. 11 – 012772.00

	Control Section	*Test Section*
Mean	4.095666667	4.176333333
Variance	0.155606333	0.162560333
Observations	3	3
Pooled Variance	0.159083333	
Hypothesized Mean Difference	0	
df	4	
t Stat	-0.247700795	
P(T<=t) one-tail	0.40828072	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.816561441	
t Critical two-tail	2.776445105	

Table 5 – t-Test – Wallagrass Route 11

6 data were used for both control and test sections for the interstate project collected each year from 2010 to 2015 while only 3 data collected every other year from 2011 to 2015 were used per section for the non-interstate project.

With the null hypothesis being: "There is no difference between the means", the analysis presented in the tables above shows that the difference between the PCR in the control section and the test section is not statistically significant because the null hypothesis couldn't be rejected for both projects (P(T<=t) two tail = 0.57 > 0.05 – Smyrna I-95, P(T<=t) two tail = 0.82 > 0.05 – Wallagrass Rt. 11).

Linear Regression Analysis

An analysis of the regression was also performed to check if the treatment life (defined for the circumstance as number of years until the PCR returns to a set value; a value of 3.5 is often used) could significantly predict the PCR value on the basis of the data collected.

- Smyrna – I-95 NB – 016819.10

HMA Control Section – without Liquid Anti-Strip

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.674809524	0.05560345	84.0741	1.2E-07	4.52043	4.829189
Age	-0.104457143	0.01836521	-5.68777	0.004718	-0.15545	-0.05347

Table 6 – Linear regression Control Section – Smyrna I-95

HMA Test Section – with Liquid Anti-Strip

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.668173526	0.06229947	74.93119	1.9E-07	4.495202	4.841145
Age	-0.133868291	0.02057684	-6.50578	0.00288	-0.191	-0.07674

Table 7 – Linear regression Test Section – Smyrna I-95

The age of the treatment for the control section as well as the test section could significantly predict the PCR (β=-0.10, $p \leq 0.01$ – Control Section; β=-0.13, $p \leq 0.01$ – Test Section). The models show that it is expected that the PCR of the control section and the test section will decrease respectively by 0.10 and 0.13 every year they remain in service without treatment. Based on the regression analysis, the control section will last more than 11 years and the test section will last for 9 years without treatment.

- Wallagrass – Rt. 11 – 012772.00

HMA Control Section – without Liquid Anti-Strip

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.658166667	0.20903482	22.28417	0.028549	2.002127	7.314206
Age	-0.1875	0.06119913	-3.06377	0.200849	-0.96511	0.590109

Table 8 – Linear regression Control Section – Wallagrass Route 11

HMA Test Section – with Liquid Anti-Strip

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.777083333	0.07937407	60.18443	0.010577	3.76854	5.785627
Age	-0.20025	0.02323835	-8.61722	0.073549	-0.49552	0.095021

Table 9 – Linear regression Test Section – Wallagrass Route 11

The age of the treatment for the control section as well as the test section cannot be significantly predicted using the data collected and the regression because the p-value in both cases is too high ($p=0.20 \geq 0.05$, Control Section and $p=0.07 \geq 0.05$, Test Section). However, based on the regression analysis, both the control and test sections could last 6 years, with a very low confidence level. This treatment life looks too low for a reconstruction project.

In addition, a recent treatment life study performed by the Research Division in coordination with Highway Program and Results & Information Office during the 2015 summer concluded that the mill and fill average treatment life on interstate roads is 9 years. This seems to fit in well with the treatment life found for the Interstate's project.

Materials

The asphalt binder used was PG 58-28 with approved anti-strip additive as stated in the project special provisions. The special provisions also specify that: "PG binders shall be unmodified and treated with 0.25 to 1.0 percent anti-strip by weight of asphalt binder used, dependent upon manufacturer and active ingredient percentage. The Contractor shall conduct testing to determine the percentage of liquid anti-strip to be used and submit the results to the Department for verification prior to production"

For this trial implementation, 0.5 percent anti-strip by weight of asphalt binder has been used. No testing was performed prior to choosing this value, however 0.5 percent seems to be an average value that is commonly used.

Quality Assurance test results for the pavement were collected during the pavement operation. Based on a review of the results there appear to be no anomalies. Table 4 includes average values for In Place Density and Asphalt Contents for both projects. For the Wallagrass project there is no density test done in the control section to compare to the density tests performed in the test section. For the project constructed in Smyrna, the average density in the control section is higher than the average density value in the test section which implies a potential difference in performance. Although this finding confirms somewhat the previous analysis of the ARAN data with regard to the interstate project, it is unreliable to draw a valid conclusion for the comparison of both sets of data because only three (3) density tests were performed in the control section compared to seventy four (74) tests in the test section. Especially when it is known that the result of the t-Test has concluded that there is no significant difference between the performance of both sections for the Smyrna I-95 project.
The table shows also that both control and test sections have the same asphalt content value.

Table 10 – HMA Test Properties for Wallagrass Rt. 11 & Houlton I-95 NB[1]

	Average In Place Density	*# of Density Tests*	*Average Asphalt Content %*	*Number of Samples for Asphalt Content Test*
Wallagrass HMA – 12.5 mm Surface (Item 403.208 with liquid anti-strip) Test Section	***94.7***	***11***	***6.0***	***5***
Wallagrass HMA – 12.5 mm Surface (Item 403.208) Control Section	***-***	***0***	***-***	***0***
Houlton HMA – 12.5 mm Surface (Item 403.208 with liquid anti-strip) Test Section	***95.19***	***74***	***5.5***	***32***
Houlton HMA – 12.5 mm Surface (Item 403.208) Control Section	***96.57***	***3***	***5.5***	***2***

Material Costs

The bid price for Houlton I-95 NB HMA on this project is $73.00/ton. This bid price includes the specified liquid anti-strip. This is a very reasonable price for HMA in today's market, particularly for

[1] Quality Acceptance test data from the TIMS database

Northern Maine. The bid price for Wallagrass Rt. 11 is $103.90 which is more than 40% higher that the bid price for Houlton.
In order to have another view of comparison, the bid history for Maine DOT projects for the last three years was reviewed.
Based on the quantity of HMA 12.5 mm NMAS placed for each project, the estimated cost per ton for the item 403.208 – 12.5 mm NMAS HMA surface should be:

Project WIN 016819.10 – Smyrna I-95 NB
For the item 403.208, the projects considered have a minimum of 14,800 Tons of HMA 12.5 mm and a maximum of 24,680 Tons with those values representing respectively 75% and 125% of 19,750 Tons – bid quantity of the item 403.208 on this project. The projects found with the unit prices are shown in the table below leading to an average price of $81.50 per Ton.

WIN	Location	Quantity	Low	Second	Third	Awd Date
18482	NAPLES-CASCO-POLA	17,570	$79.00	$78.00	$83.00	May-14
22589	MORO PLANTATION-T	19,730	$84.00			Apr-16

Table 11 – Bid history prices for item 403.208 – Projects with quantities nearly equal to Smyrna project

Project WIN 012772.00 – Wallagrass Rt. 11
The projects considered were selected in the range 2,495 Tons and 4,325 Tons of item 403.208 with those limits representing respectively 75% and 125% of 3,460 Tons – bid quantity of the item 403.208 on this project. The projects found with the unit prices are shown in the table below leading to an average price of $89.40 per Ton

WIN	Location	Quantity	Low	Second	Third	Awd Date
20246	AUBURN ROUTE 122	2,600	$78.00	$78.80	$91.00	Jun-14
17296	AUGUSTA, HIGHWAY	3,100	$95.00	$100.00	99	Jun-15
20854	AUGUSTA TO WATERV	3,150	$67.00	$74.00		May-16
20446	PRESQUE ISLE - WA	3,200	$98.45	$104.00	125	Jun-14
17889	WARREN, HIGHWAY R	3,200	$98.00	$107.00	$97.00	Jun-14
20397	PITTSFIELD, SOMER	3,200	$85.00	$95.00	98	May-14
10011	MILFORD, HIGHWAY	3,300	$120.00	$92.00	$94.00	Feb-16
20389	BREWER, WILSON ST	3,600	$86.00	$116.00	121	Jun-15
18629	FALMOUTH, ROUTE 1	3,740	$68.00	$75.00	$78.00	Jun-16
18494	BIDDEFORD WEST S	3,760	$93.00	$87.00	87	May-14
20382	PITTSFIELD-FAIRFI	3,850	$82.00	$74.00		Apr-16
20430	FORT KENT ROUTE 1	3,950	$102.00			Jun-15

Table 12 – Bid history prices for item 403.208 – Projects with quantities nearly equal to Wallagrass project

As one would expect the cost per ton also depends on the total quantity to be placed and the more the quantity is, the less the price per ton should be. That is why the bid price for the item 403.208 in Wallagrass is more expensive than the price of the same item in Smyrna.
However, the comparison of the actual cost to the average cost obtained by reviewing the bid history for Maine DOT projects during the last three years shows that the bid price for the item 403.208 for Smyrna

I-95 NB is 10% less than the average bid history price. Contrariwise, the bid price for Wallagrass for the same item 403.208 is 15% more expensive than the average bid history price.

	Item 403.208 - Actual Price ($/Ton)	Item 403.208 - Three years Average of bid history ($/Ton)	Difference between Actual Price and Average of Bid History ($/Ton)
WIN 016819.10 - Smyrna I-95 NB	73.00	81.50	-8.50
WIN 02772.00 - Wallagrass Rt. 11	103.90	89.40	14.50

Comparative table of bid prices and three years average bid history

Photos

The following series of photos compare the test section to the control section. Both series of photos are from the ARAN network collection files taken in 2011 and 2015 when both projects were respectively one year post paving (left column) and five years post paving (right column). With the pictures, there is no significant difference between the test section and the control section for both projects as concluded after the ARAN data analysis.

Figure 2-Wallagrass Rt. 11, RLM 13.851 - Test Section - 2011

Figure 3- Wallagrass Rt. 11, RLM 13.852 - Test Section - 2015

Figure 4-Wallagrass Rt. 11, RLM 14.410- Control Section - 2011

Figure 5-Wallagrass Rt. 11, RLM 14.416- Control Section - 2015

Figure 6-Smyrna I-95 NB, RLM 14.964 - Test Section - 2011

Figure 7- Smyrna I-95 NB, RLM 14.983 Test Section - 2015

Figure 8- Smyrna I-95 NB, RLM 26.506 - Test Section - 2011

Figure 9- Smyrna I-95 NB, RLM 26.506 - Test Section - 2015

Figure 10-Smyrna I-95 NB, RLM 27.157 - Control Section - 2011

Figure 11-Smyrna I-95 NB, RLM 27.157 - Control Section - 2015

Conclusions

General observations from Region 5 Highway Program staff that were involved with both projects were not favorable to the performance of the liquid anti-strip. This was reported almost immediately after paving was completed in 2010. The review of the ARAN data over a five years period supports this initial assessment. Both the test and control sections for both projects showed the typical surface wear. It appears consequently that the addition of the liquid anti-strip didn't improve the performance of the mixture. However it should to be noted that the percentage of liquid anti-strip used was based on judgement rather than testing.

Prepared by:

Ulrich Amoussou-Guenou
Assistant Engineer / Transportation research Division
Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016
Tel. 207-624-3277
e-mail: ulrich.amoussou-gueno@maine.gov

Dale Peabody
Transportation Research Engineer
Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016
Tel. 207-624-3305
e-mail: dale.peabody@maine.gov

Appendix

SPECIAL PROVISION

SECTION 401

HOT MIX ASPHALT PAVEMENTS

(Liquid Anti-Strip)

401.01 Description The Contractor shall furnish and place one or more courses of Hot Mix Asphalt Pavement (HMA) on an approved base in accordance with the contract documents and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Resident. The Department will accept this work under Quality Assurance provisions, in accordance with these specifications and the requirements of Section 106 – Quality, the provisions of AASHTO M 323 except where otherwise noted in sections 401 and 703 of these specifications, and the Maine DOT Policies and Procedures for HMA Sampling and Testing.

MATERIALS

401.03 Composition of Mixtures This section has been amended as follows:

The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB) with liquid Anti-strip, and mineral filler if required. The required PGAB for this mixture will meet a PG 58-28 or PG 64-28 grading. All asphalt grades utilized on the travelway and ramps shall be treated with an approved liquid anti-strip. PG binders shall be unmodified and treated with 0.25 to 1.0 percent anti-strip by weight of asphalt binder used, dependent upon manufacturer and active ingredient percentage. The Contractor shall conduct testing to determine the percentage of liquid anti-strip to be used, and submit the results to the Department for verification prior to production.

For the purposes of comparative testing, a control strip shall be constructed. The control strip section shall be constructed with an approved JMF, produced without liquid anti-strip additives. The HMA design shall be submitted with the same aggregate, aggregate percentages, asphalt supply, and asphalt target percentages as the JMF utilizing liquid anti-strip.

401.031 Liquid Anti-Strip

The Contractor shall specify the type of liquid anti-strip to be utilized to produce mixtures for use on the project. The required PGAB for mixtures will meet a PG 58-28 or PG 64-28 grading. All asphalt grades

utilized on the travelway and ramps shall be treated with an approved liquid anti-strip. PG binders shall be unmodified and treated with 0.25 to 1.0 percent anti-strip by weight of asphalt binder used, dependent upon manufacturer and active ingredient percentage. The Contractor shall stipulate which PGAB grading will be used to construct the entire HMA pavement

structure prior to starting work. Changes to the PGAB grading must be approved by the Department prior to the change in PGAB grading.

Establishment of Control Strip - The Contractor shall place a control strip for each mixture type consisting of Hot Mix Asphalt Pavement produced without liquid anti-strip. Prior to the placement of the control strip a passing verification test is required. The control test strip shall be placed over the full width of the travel way section, not to exceed 1000 ton production per lane. The control strip will not be excluded from QA analysis, but will be evaluated in accordance with Section 401.03. The Contractor shall notify the Department at least 48 hours in advance of placing the control strip.

Control strips shall be required for all mixtures to be utilized in the contract. Wearing, shim, or lower lift base mixtures shall be placed as required within the control strip limits. A minimum of three mixture samples shall be randomly selected from the control strips and evaluated under Method B criteria. A minimum of three core samples shall be randomly selected from wearing or lower lift base course control strips and evaluated under Method B criteria. After completion of the control strip, the Contractor shall make any final adjustments to the job mix formula in accordance to Standard Specifications, Section 401, subsection 401.03 - Composition of Mixtures, or compaction method. Any changes to the control strip JMF shall result in a change in the JMF using liquid anti-strip to identical target values. Paving operations shall not resume until the Contractor and the Department determines that material meeting the Contract requirements can be produced, and any changes to the Job Mix Formula have been approved by the Department. The Department shall pay for an accepted control strip as determined Section 401.222 – Pay Factor A and B, for this item. A new control strip shall be required if a current JMF is terminated, and a new JMF is started.

Once established, all production methods, equipment, and JMF's will become part of the QCP. The control strip will allow for any necessary adjustments to the mix design and or plant mixing procedures, as well as for the Department to evaluate the quality of the pavement.

Payments will be made under:

Pay Item			Pay Unit
403.207	19.0 mm	Hot Mix Asphalt Base	Ton
403.208	12.5 mm	Hot Mix Asphalt Surface	Ton
403.210	9.5 mm	Hot Mix Asphalt	Ton
403.211	9.5 mm	Hot Mix Asphalt Shim	Ton
403.212	4.75 mm	Hot Mix Asphalt Shim	Ton
403.213	12.5 mm	Hot Mix Asphalt Base	Ton