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Maine Department of Transportation

Transportation Research Division

Technical Report 03-1

Bridge Deck Resurfacing using Rosphalt 50

Construction Report - January 2003

Transportation Research Division

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Introduction

Most bridge decks in Maine are comprised of Reinforced Portland Cement Concrete (RPCC). Although a durable product, RPCC is permeable and susceptible to chloride penetration leading to corrosion of the steel reinforcement and eventual cracking of the bridge deck.

To delay this from occurring, the deck surface is sealed with a latex modified Portland Cement Concrete (PCC) wearing course or a combination of waterproofing membrane and Hot Mix Asphalt (HMA). Each surface treatment has a life expectancy of 15 to 25 years. The latex modified PCC is still vulnerable to chloride penetration but at a much lower rate. The membrane/HMA treatment protects as long as the membrane is intact.

Rosphalt 50 is another product that has been used since 1983 to seal bridge decks. This is a proprietary asphalt additive developed by Royston Laboratories a Division of Chase Corporation in Pittsburgh, PA. It consists of concentrated thermoplastic virgin polymeric materials that, when added to HMA during the mixing process, combines with the asphalt to create an asphalt paving product that seals the RPCC deck and provides a wearing course in one application. Independent Chloride Ion Penetration tests have shown that only negligible chloride ions were transmitted through Rosphalt 50. Additional tests of Rosphalt 50 show that it meets Superpave binder criteria at temperatures of 94˚C to -34˚C. Royston claims the product displays good skid resistance, resists rutting better than Superpave mix, and has a life expectancy of 20 - 25 years. Another characteristic of Rosphalt 50 is that it retains its shape and doesn't soften and flow during prolonged exposure to high temperatures.

This paper will outline the mix design process, bridge deck surface preparation, construction, and initial evaluation of three bridge decks with Rosphalt 50.

Objective

The objective of this project was to overlay three bridges in Maine with Rosphalt 50 to seal the bridge deck and provide a wearing surface. The product will be evaluated over a five-year period for: Skid Resistance, Permeability, Durability and Cost Effectiveness.

Location

Two bridges are located in the town of Howland (Figure 1). Bridge number 6070 is on the southbound lane of Interstate 95 and crosses Seboeis Road. This bridge is 41 meters (136 ft) in length and 14 meters (47 ft) wide with a 2001 AADT of 3980. The wearing surface was in poor condition and needed replacement (Photo 1). Bridge number 6069 is also on the southbound lane of Interstate 95 and crosses the Piscataquis River. This bridge is 163 meters (536 ft) long, 11 meters (36 ft) wide with a 2001 AADT of 3980. The wearing surface on this bridge was also in poor condition (Photo 2).

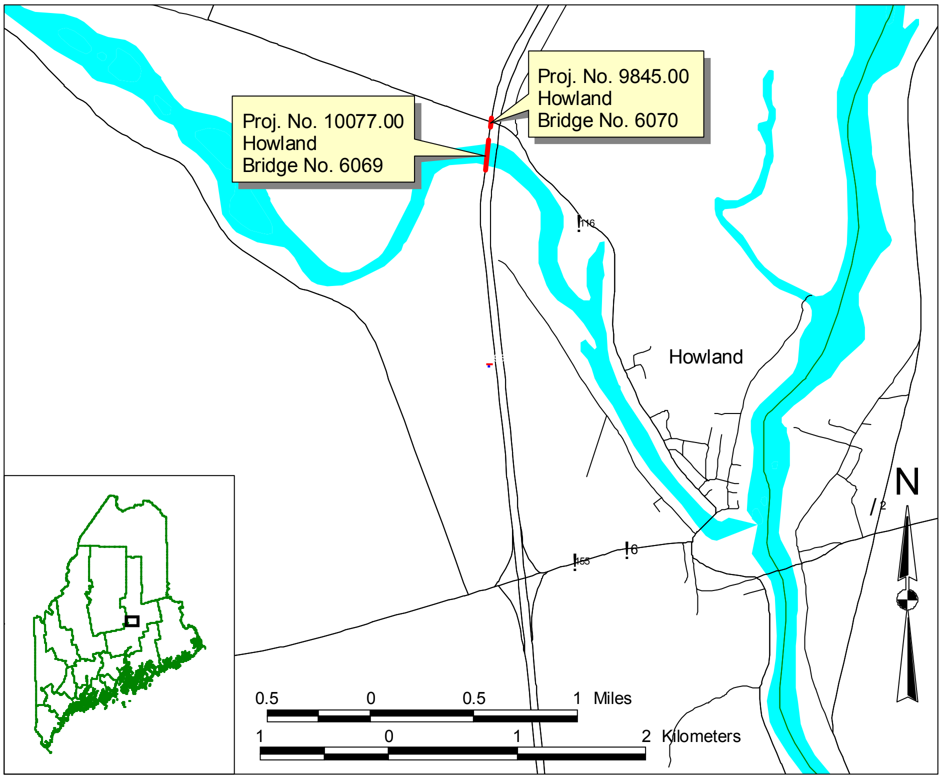

Figure 1. Bridge #6069 and 6070 location map

Photo 1. Bridge #6070 wearing surface

Photo 2. Bridge #6069 wearing surface

The third bridge is located between the cities of Bangor and Brewer (Figure 2). Bridge number 1558 is 476 meters (1563 ft) long, 33 meters (108 ft) wide, has a 2001 AADT of 13503, and carries Interstate 395 traffic over the Penobscot River.

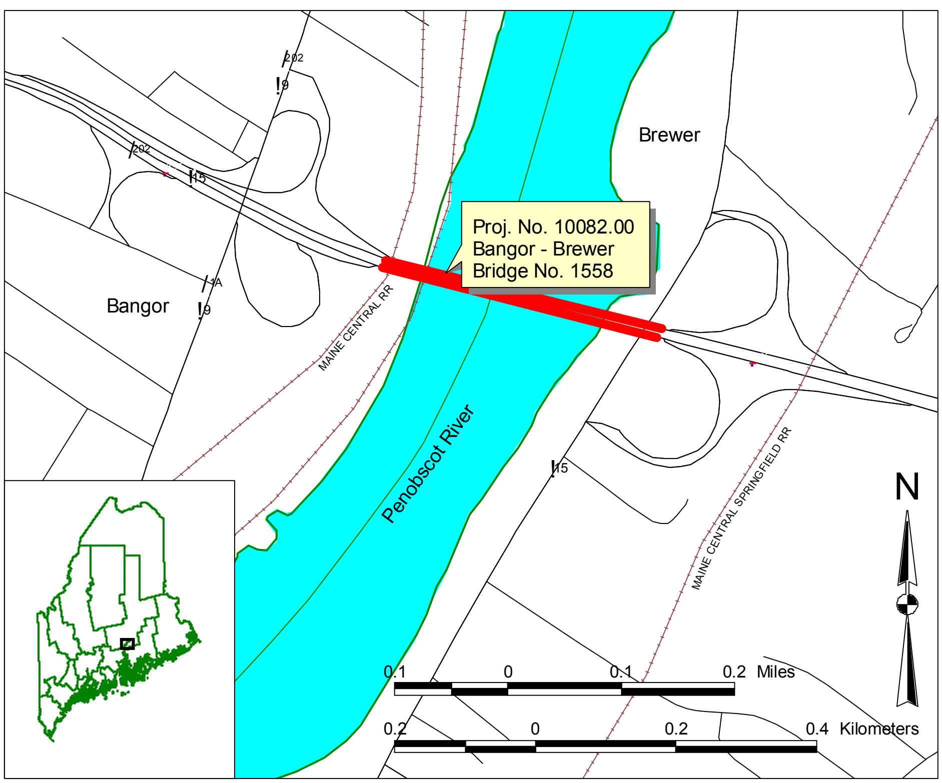

Figure 2. Bridge #1558 location map

Although the wearing surface was in fair condition, there were areas of shoving that have been repaired over the past five years (Photos 3 & 4). The problem areas are located on the accelerating lane of each entrance ramp and decelerating lane of each exit ramp.

Photo 3. Bridge # 1558 patch area on entrance ramp

Photo 4. Bridge # 1558 patch area on exit ramp

Scope

Two construction procedures were used for this project. One procedure involved milling the bituminous pavement and leaving the bridge deck membrane intact prior to resurfacing. The other consisted of removing the deck membrane and existing bituminous pavement prior to resurfacing.

Bridge number 6069 and 6070 had the deck membrane replaced in 1990 and 1988 respectively. Bridge inspectors determined that the membrane was still intact and protecting the deck from chloride intrusion. Because of this, bituminous pavement was removed to within 6 mm (0.25 in) of the bridge deck leaving the deck membrane intact. The surface was brushed clean and tack coated with Royston's 754 Adhesive Tac Coat. All vertical faces that will be in contact with Rosphalt 50 were tacked with Royston's 120-29 Edge Sealer. Both bridges were paved with 50 mm (2 inches) of Rosphalt 50 rubberized asphalt paving mix.

Bridge number 1558 had a number of areas that have been repaired the past 10 years due to either deck membrane failure or pavement failure. It was determined to remove the bituminous pavement and deck membrane prior to resurfacing. After milling, the bridge deck was cleaned and tacked with Royston's 754 Tac Coat. Royston's 120-29 Edge Sealer was applied on all vertical surfaces and the bridge was surfaced with 75 mm (3 inches) of Rosphalt 50 in two lifts.

Rosphalt 50 seals the deck without applying a new deck membrane and reduces the amount of time to resurface the bridge, which reduces the amount of traffic control necessary to resurface the deck.

Materials

Materials used for this project include:

9.5 mm Nominal Maximum Aggregate Size Superpave mix with Rosphalt 50 additive
Royston 120-29 Edge Sealer
Royston 754 Tac-Coat

The bid item for Rosphalt 50 High Performance Rubberized Asphalt included application and placement of all materials listed above.

Cost Comparison

Resurfacing using 50 mm (2 inches) of bituminous pavement (Bridge # 6069 and 6070)

Resurface Only (estimated costs)		
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$7.06 / m^2
	Total	$7.67 / m^2
Resurface plus Waterproofing Membrane (estimated costs)		
Waterproofing Membrane		$20.86 / m^2
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$7.06 / m^2
	Total	$28.53 / m^2

Resurfacing using 50 mm (2 inches) of bituminous pavement (Bridge # 6069 and 6070) continued

Resurface plus High Performance Waterproofing Membrane (estimated costs)		
High Performance Waterproofing Membrane		$32.69 / m^2
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$7.06/ m^2
	Total	$40.36 / m^2

Resurface using Rosphalt 50 (bid price)		
Rosphalt 50 (Includes Royston 754 Tac-Coat and Edge Sealer 120-29)		$38.16 / m^2

Resurfacing using 75 mm (3 inches) of bituminous pavement (Bridge #1558)

Resurface Only (estimated costs)		
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$10.62 / m^2
	Total	$11.32 / m^2

Resurface plus Waterproofing Membrane (estimated costs)		
Waterproofing Membrane		$20.86 / m^2
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$10.62 / m^2
	Total	$32.09 / m^2

Resurface plus High Performance Waterproofing Membrane (estimated costs)		
High Performance Waterproofing Membrane		$32.69 / m^2
Bituminous Tack Coat		$0.61 / m^2
9.5 NMAS Superpave		$10.62 / m^2
	Total	$43.92 / m^2

Resurface using Rosphalt 50 (bid price)		
Rosphalt 50 (Includes Royston 754 Tac-Coat and Edge Sealer 120-29)		$57.39 / m^2

Formula to determine cost of mix:

Mix Quantity × mix cost ÷ bridge deck area

Where:

Actual Mix Quantity used:

- Bridge #6069 = 211 Mg (233 ton)
- Bridge #6070 = 70 Mg (77 ton)
- Bridge #1558 = 2790 Mg (3075 ton)

Mix Cost:

- Actual cost of Rosphalt 50 = $322.43 / Mg (292.50 / ton)
- Estimated cost of 9.5 mm NMAS Superpave = $59.67 / Mg ($54.13 / ton)

Area of bridge deck:

- Bridge #6069 = 1781 m^2 (2130 yd^2)
- Bridge #6070 = 593 m^2 (709 yd^2)
- Bridge #1558 = 15674 m^2 (18746 yd^2)

The estimated costs for 9.5 mm NMAS Superpave, Waterproofing Membrane, and High Performance Waterproofing Membrane are based on the average unit cost of each item over the past three years.

The estimated cost for Tack Coat is the average unit cost per liter ($3.07) at an application rate of 0.20 L/m².

The costs above do not include traffic control costs. It took ten days of paving to resurface all three bridge decks with Rosphalt 50. It was estimated that it would take fifteen to seventeen days to apply a waterproofing membrane and resurface with Superpave.

Using Rosphalt 50 to resurface bridge number 6069 and 6070 is less costly than resurfacing with a high performance waterproofing membrane but significantly more than resurfacing with or without a conventional waterproofing membrane.

When the thickness of Rosphalt 50 is increased by 25 mm, as is the case for bridge # 1558, the price of resurfacing is significantly higher than all other bridge deck treatments.

Mix Design

Aggregate samples from Lane Construction Co. were sent to Royston laboratories for analysis, blending and Marshall tests.

The following tables contain mix design results from Royston Laboratories:

Table 1. Aggregate properties

SIEVE SIZE	PERCENT PASSING
12.5 mm (1/2 in)	96 - 100
9.5 mm (3/8 in)	89 - 97
4.75 mm (#4)	62 - 70
2.36 mm (#8)	41 - 47
1.18 mm (#16)	22 - 28
600 µm (#30)	13 - 19
300 µm (#50)	10 - 13
150 µm (#100)	5 - 8
75 µm (#200)	3.1 - 6.1

Table 2. Mix Composition Per Ton

MATERIAL	PERCENTAGE	WEIGHT
12.5 mm (1/2 in) stone	9.125	82.8 kg (182.5 lb)
9.5 mm (3/8 in) stone	9.125	82.8 kg (182.5 lb)
9.5 mm (3/8 in) minus stone	36.50	331.1 kg (730 lb)
Washed Ledge Sand	36.50	331.1 kg (730 lb)
PG 64 - 28 Binder	6.50	59 kg (130 lb)
Rosphalt 50	2.25	20.4 kg (45lb)
Total	100 %	907.2 kg (2000 lb)

Table 3. Specific Gravity

Theoretical Specific Gravity	-	2.383
Actual Specific Gravity	-	2.349

Table 4. Physical Properties of Marshall Specimens

% AC (PG 64-28)	Plug #	Height (in)	Corr. Ratio	Load	Stability	Flow	% Voids in Mix
6.50 50 Blows	1	2 ½	1.00	3050	3050	27.5	1.62
	2	2 ½	1.00	2950	2950	26.5	1.20
	3	2 ½	1.00	2950	2950	26.5	1.42
	Royston Results			AVERAGE	2983	26.8	1.41

Table 5. Recommended Mix Temperatures

Plant temperature of Rosphalt 50 Asphalt	- 218 ± 8° C (425 ± 15° F). Maximum 232 ° C (450° F)
Lay down temperature of Rosphalt 50 Asphalt	- 191 - 210° C (375 - 410° F)
Breakdown rolling temperature	- 149 - 210° C (300 - 410° F)
Finish rolling temperature	- 121 - 149° C (250 - 300° F)

Royston requires that during installation, compaction of this Rosphalt 50 mix design be 96% of theoretical compaction.

The job mix formula was not available for review at the pre construction meeting.

Construction

Royston had two representatives, one at the plant and one on the project, to monitor batching and placement of Rosphalt 50 enhanced bituminous material. It was agreed that MDOT personnel could point out discrepancies but Royston would have control of correcting problems or rejecting mix. Lane Construction Corporation, Bangor Me., was contracted to mill and seal the bridge decks. All work had to be completed by October 31, 2002.

Howland Bridge #6069 and #6070

Bridge Deck Preparation

Construction began on September 13, 2002 with covering the bridge drains to prevent contamination under the bridge. A Wirtgen 2100 DC milling machine was used to mill the travel lane of bridge number 6069 and 6070. Bituminous material was milled to a depth of 50 mm (2 in) leaving approximately 6 mm (0.25 in) of bituminous material and the waterproof membrane intact.

While milling an area of bridge # 6069, the deck membrane was corrupted (Photo 5). The milling machine was raised 6 mm (0.25 in) to avoid disturbing the remaining waterproof membrane. Prior to construction, MDOT Bridge Maintenance Division was asked to replace joint seals and repair areas with deteriorated PCC bridge deck or waterproof membrane after the bridge decks were milled. When notified of the membrane damage, Bridge Maintenance had to send for patch material, which would take one or two days to deliver and an additional one or two days to repair. Due to the limited number of construction days and the fact that Rosphalt 50 enhanced bituminous material seals bridge decks, a decision was made

Photo 5. Damaged membrane on bridge # 6069

to cut away loose membrane material from the deck and the exposed bridge deck would then be sealed when resurfaced with Rosphalt 50. After the travel lane was milled, the surface was brushed clean and allowed to dry. Royston Edge Sealer 120-29 was applied on all vertical surfaces (Photo 6) and the deck was tack coated with Royston 754 Tac-Coat (Photo 7) and allowed to cure overnight.

Photo 6. Royston 120-29 Edge Sealer

Photo 7. Royston 754 Tac-Coat

Trial Batch

Construction began on September 18, 2002 with trial batching at Lane Construction's Sunrise Division in Orono, Me. A two-ton batch plant was used to introduce Rosphalt 50 into the mix. Trial batching began with increasing the hot bin aggregate temperature to 246° C (475° F) and blending with a small amount of binder to check dry mix temperatures in a loaded truck. This produced dry mix temperatures of 232° C (450° F). A second dry load was batched using the same hot bin aggregate temperatures. This also produced a load of dry mix at a temperature of 232° C (450° F).

The third trial batch included Rosphalt 50. Each bag of Rosphalt 50 weighs 10 kg (22.5 lb) and four bags were necessary to batch a two-ton load. Four bag groups of Rosphalt 50 were loaded onto a conveyor belt that feeds directly into the pug mill (Photo 8). Mix sequence in the pug mill was; blend aggregate and Rosphalt 50 for 10 seconds then introduce asphalt binder and blend for 90 seconds. Hot mix aggregate temperature was raised to 266° C (510° F) to compensate for the ambient temperature of Rosphalt 50 material. There were problems with the bags of Rosphalt 50 feeding into the pug mill on the first two-ton drop. The bags were not dropping into the pug mill properly and were plugging the access hatch. Spacing the bags apart on the conveyor belt did not correct the problem so the bags were manually fed into the pug mill to finish the first wet trial batch. Mix temperature of the first truck was 233° C (451° F). This load was not used on the project.

Manually feeding the bags was not an option and the plant was shut down for modifications to the pug mill access hatch. After the modification, a second wet trial batch was attempted and the bags of Rosphalt 50 fed properly. The second wet trial batch temperature was 238° C (460° F). Although the temperature was higher than specifications allowed, Royston representatives accepted the load and sent it to the project. Second and third truckloads of material had temperatures of 227 and 233° C (441 and 452° F) respectively.

Photo 8. Feeding Rosphalt 50 into the pug mill

Distance between plant and project was 58 km (36 mi) and it took approximately one hour to deliver each load of bituminous material. Royston was adamant about covering the load to prevent material cooling while in transit. Covers were specifically made for each truck to completely cover the load (Photo 9). The covers worked very well at keeping mix temperatures from dropping. Day one average plant temperature

Photo 9. Truck bed cover

was 233° C (451° F); average job site temperature was 229° C (445° F). Table 6 contains a summary of plant and jobsite mix temperatures for the two Howland bridges.

Table 6. Bridge #6069 and #6070 mix temperature summary

Mix Temperatures		
Location	Plant	Jobsite
Number of Tests	10	7
High	460.5	465
Low	440.5	420
Average	451.2	438.6
Standard Deviation	6.0	17.0

Resurfacing

Prior to paving, Royston representatives outlined rolling patterns and suggested there be two breakdown rollers at the jobsite. The mix is rolled at such a high temperature that the rollers will use twice the amount of water. While one roller is watering, the other can continue compaction. Rolling patterns are also different. The breakdown roller should follow the paver closely making a single pass to the paver on the low side of the mat then returning in the same path. The second pass should be next to the previous run, down to the paver and back in the same path; this pattern is repeated to the high side of the mat. Crossing patterns should be avoided as much as possible. The finish roller should repeat the pattern closely behind the breakdown roller to achieve density of the mat. Once density is achieved, the operator can finish rolling additional areas. Cosmetic rolling should be completed while the mat is above 121° C (250° F). All handwork must be completed while the mix is still very hot and broadcasting of the mix is not recommended.

The first load arrived with a temperature of 241° C (465° F), 3° C higher than the plant temperature. It was suggested that thermometers be checked for accuracy. The mix began to tear behind the paver because of the high temperature. Royston instructed the paver operator to reduce speed until the mix cooled for proper placement. This reduced the amount of tearing and the plant was notified to reduce the mix temperature. Succeeding loads arrived at or below 235° C (455° F).

Paving went smoothly and Royston monitored placement and compaction very closely. One concern was the amount of smoke generated from the hot mix being placed on the bridge deck (Photo 10) causing a potentially hazardous traffic safety problem that could not be avoided. Workers around the paver were advised to be cautious. Lane Construction used three trucks to deliver material. This caused delay between loads that cooled material in the paver to levels below lay down specification. MDOT personnel requested another truck be outfitted with a cover to deliver material and reduce the amount of delay. As paving proceeded, bridge drain covers were removed and material around them was hand compacted. Breakdown roller lines were smoothed with the finish roller leaving a very smooth mat.

Passing lane preparation began on September 19, 2002 with milling the bituminous surface plus 25 mm (1 in) of Rosphalt 50, to create a vertical edge, to a depth of 50 mm (2 in) leaving the waterproof membrane intact. All vertical surfaces including Rosphalt 50 were treated with Royston 120-29 Edge Sealer. The deck was tacked with Royston 754 Tac-Coat and allowed to cure. The deck was sealed with Rosphalt 50 on September 21, 2002. Although there were delays between trucks, paving went smoothly. The finished product looked very smooth with very few blemishes.

Photo 10. Poor visibility

Bangor - Brewer Bridge #1558

Bridge Deck Preparation

The Veterans Memorial Bridge is a six-lane bridge with wide transition areas at the eastbound entry ramp and westbound exit ramp (Fig. 3). Construction began on September 29, 2002 with removing all bituminous material plus the waterproofing membrane from the transition area, ramp and travel lane on the eastbound side. Four small areas of the RPCC deck that ranged in size from 1 to 0.3 m^2 (1 to 0.3 yd^2) were deteriorated and were repaired by Bridge Maintenance. The remaining deck was in great shape.

Resurfacing

Paving began on October 1, 2002 with placing a 3.7 m (12 ft) wide and 38 mm (1.5 in) thick mat of Rosphalt 50 on the travel lane, transition area, and ramp of a small section of the western end of the east bound side of the bridge. This is a small area of the bridge, about 100 meters in length, which bridges a railroad yard and acts as an expansion buffer for the main bridge. Material on the first lane flushed, possibly due to over compaction. Changes to rolling patterns were made to correct the problem and the remaining lanes were paved with no incident.

Paving on the main bridge began on October 2, 2002 with placing a 3.7 m (12 ft) wide and 38 mm (1.5 in) deep mat of Rosphalt 50 on the transition area, entrance/exit ramp and drains. Material around the drains did not appear to be compacted properly (Photo 11) and there was concern that the bridge deck in these areas would not be sealed properly. Balls of rubber material were noticed in the mat and pointed out to Royston personnel. Royston assured the construction engineer that the material would knit into the mat during compaction. Locations of these areas were logged for future evaluation.

There were long delays between finishing one lane and beginning another, allowing mix in the loaded trucks to cool. Mix in the paver hopper was not removed prior to starting another lane resulting in placing

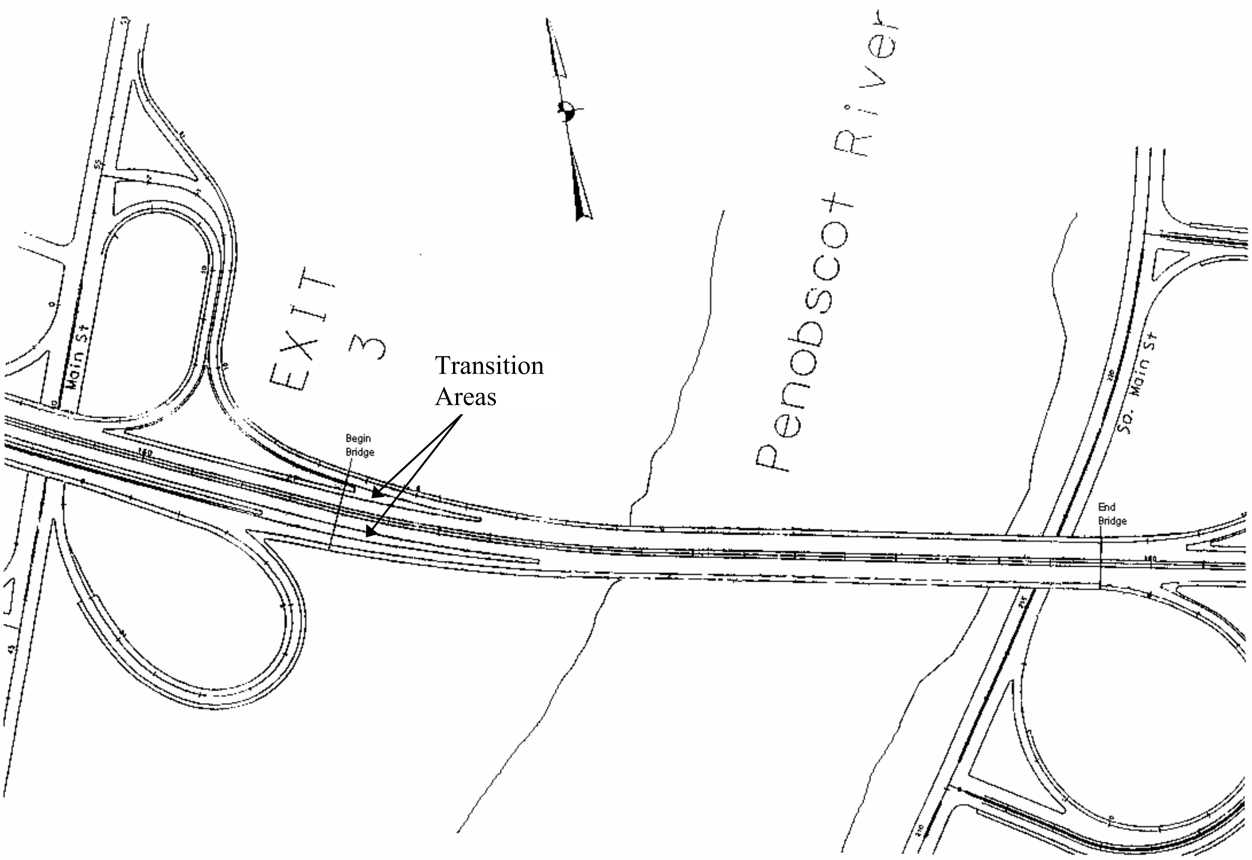

Fig. 3 Bangor - Brewer Bridge #1558 detail

cold mix at the start of the next lane. This resulted in a mat that looked very coarse (Photo 12). This continued until hot mix was reintroduced to the screed. Rosebud torches were used on the mat in these areas to increase mix temperature and improve compaction.

Paving continued into nightfall and darkness made it difficult to monitor construction. The contractor ran out of mix at the end of the travel lane and tried using header material to finish the mat. This mix was too cold to work with and tore during placement. By request of Royston, the mix was removed (Photo 13) and paved with hot mix the following day.

Placing the second lift of Rosphalt 50 went smoother than the first, but there were problems. Balls of material were noticed in the mat on this lift also. Prior to placing the second lift around the drains, hot mix was hand placed and compacted around drains that appeared to have poor compaction. Hand compaction of the second lift around drains had improved.

Areas along the granite curb, where the mat is tapered to compensate for the curved transition area of the bridge deck, appeared inadequately compacted (Photo 14).

The distance between the knockdown and finish roller was so great in some areas that the finish roller had a difficult time smoothing knockdown roller lines because the mat was too cool. This was pointed out and corrected.

Photo 11. Poor compaction around drains.

Photo 12. Cold mix at beginning of lane.

Because of the difficulties encountered in paving this section of the bridge, a meeting was held with FHWA personnel, MDOT personnel, Royston and Lane Construction. Items that were addressed and corrected before placing additional mix include:

1. Due to sensitivity of the mix being over compacted and possibly tearing, the knockdown roller was reduced in size from a 10 ton to an 8 ton machine.
2. Requesting Lane Construction follow pre-construction guidelines to keep a full head of material in front of the screed when approaching a butt joint.
3. Royston and MDOT thermometers will be checked for accuracy and that plant and lay down temperature specifications will be followed.
4. More attention will be given to drain areas to increase density of material.
5. Addressed trucks waiting to be unloaded and the mix cooling down, trucks will be spaced evenly to reduce this problem.
6. Lane Construction agreed to periodically empty the paver hopper to eliminate balls of cold material on the mat.

Paving the remaining bridge deck went smoothly and the finished surface looked very good. Table 7 contains average plant and jobsite mix temperatures for Bridge #1558.

Table 7. Bridge #1558 mix temperature summary

Mix Temperatures		
Location	Plant	Jobsite
Number of Tests	165	42
High	453	445
Low	403	375
Average	431.3	413.2
Standard Deviation	10.8	18.9

Photo 13. Removal of cold mix.

Photo 14. Poorly compacted wedge area.

Project Evaluation

Marshall Test Results

Table 7 contains volumetric and gradation test results. Eleven samples were tested. Nine failed either gradation, flow, or void in mix specifications. Tests were performed by Lane Construction and reviewed by Royston. Test results were not available to MDOT personnel until the project was completed. Other than the first truckload during trial batching, no loads of mix were rejected by Royston representatives during construction.

Specific Gravity

MDOT wanted to cut bridge deck cores to measure density of the material. Royston stated that the five year guarantee, that covers the Rosphalt 50 material only and not the actual mix or placement of materials, would be void if cores were cut on the bridge decks. To check material density, a small section of roadway behind the south joint of bridge #6069 over the approach slab was patched with Rosphalt 50. Two cores were cut in this area and the results are presented in Table 8.

Table 7. Volumetric and gradation summary

HMA Marshall Volumetric Summary											
Test Date	Howland 9-18	Howland 9-21	Bangor 10-1	Bangor 10-2	Bangor 10-12	Bangor 10-14	Bangor 10-15	Bangor 10-15	Bangor 10-17	Bangor 10-19	Bangor 10-24	Limits
Density kg/m^3	2348	2356	2360	2348	2344	2344			2347	2361	2388	
Specific Gravity (Gmm)	2.381	2.395	2.379	2.380	2.387	2.398			2.387	2.379	2.388	
% Void in Mix	1.34	1.60	0.80	1.27	1.80	2.30			1.62	0.71	0.80	0 - 2
Stability	3440	3056	3162	2976	3207	3444			3304	3192	3040	
Flow	32.0	28.7	31.7	27.0	34.0				20.2	33.5	33.2	15- 30
Binder Content (ignition)		8.9	9.1	9.1	9.3	9.0	9.5	9.3	9.4	8.9	8.9	
Bitumen Content		6.2	6.4	6.4	6.6	6.3	6.8	6.6	6.7	6.2	6.2	5.5- 7.0
HMA Gradation Summary												
Sieve	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	Limits
12.5 mm	100	100	100	100	100	100	100	100	100	100	100	100
9.5 mm	94	94	92	94	94	95	95	96	97	96	93	90-97
4.75 mm	66	67	71	70	71	74	71	74	76	70	68	62-70
2.36 mm	41	43	46	43	45	45	45	47	50	47	45	41-47
1.18 mm	25	26	28	25	28	27	28	29	31	30	30	22-28
600 µm	17	17	18	17	19	17	19	19	20	21	21	13-19
300 µm	12	12	12	12	13	12	14	13	13	15	15	10-13
150 µm	8	8	8	8	9	9	10	9	8	10	10	5-8
75 µm	5.9	6.0	5.2	5.6	6.6	6.4	6.7	6.0	5.6	7.0	6.7	3.1-6.1
Pass/Fail	F	P	F	P	F	F	F	F	F	F	F	

Table 8. Core density summary

Core Number	1	2
Gmb	2.274	2.289
Gmm	2.383	2.383
Density	95.4%	96.1%
Voids	4.6%	3.9%

As mentioned earlier, Royston's minimum density requirements are 96% of Theoretical Maximum Density. Core number one failed despite Rosphalt instructing the roller operator to make additional passes on the patched area.

Frictional Resistance

Frictional tests were collected on November 12, 2002. A Frictional Number (FN) below 35 in the state of Maine is considered failing. Test results in Table 9 show that all bridge decks pass with a low average FN of 41.8 and a high FN of 43.1.

Table 9. Frictional resistance summary

Bridge Number	Howland #6070	Howland #6069	Bangor #1558
Number of Tests	4	9	29
High FN	46	47	49
Low FN	40	35	36
Average FN	43.0	41.8	43.1
Standard Deviation	2.58	3.99	3.76

Rosphalt 50 will be evaluated over a five-year period. Frictional Resistance tests will be collected on an annual basis in hot and cool conditions to determine if frictional characteristics vary with temperature or over time. A visual inspection will be conducted annually to check for cracking or shoving. Rut depth measurements will also be collected on an annual basis. In the spring of 2003 and once again in 2007, all bridge decks will be tested for permeability and core samples will be cut to determine how well the material has bonded to the deck, measure density of the bituminous material, and test the RPCC for chloride penetration.

Conclusion

It was felt by the construction engineer and others that control of the construction process was very casual. Specifications were not being adhered to, pre paving guidelines were not followed, rolling patterns were changed, and placement procedures were changed by Royston field representatives.

More control over materials is necessary to assure a quality product is produced and constructed. It is suggested that job mix formulas from Royston should be available prior to pre construction meetings to discuss specification limits. Marshall test results should be available for review by MDOT to monitor changes in material during placement.

Royston representatives had control of production and placement of the product but at times did not follow their own specification limits during construction. If MDOT plans to use this product to seal additional bridge decks, it is recommended that MDOT and Royston clearly outline specification limits, construction procedures, and mix temperature limitations and that MDOT personnel have the capability of rejecting material that does not meet specifications. In addition, cores should be cut to monitor mix density during construction.

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