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MaineDOT

Transportation Research Division

Technical Report 03 - 1

Bridge Deck Resurfacing Using Rosphalt 50

Interim Report - Second, Third, and Fourth Year
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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 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 sealed 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).

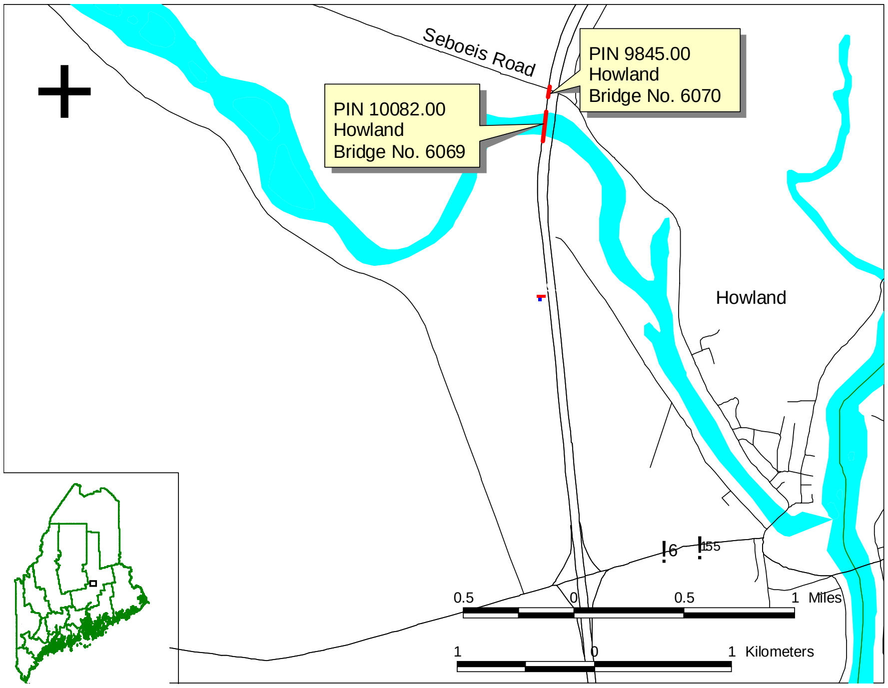

Figure 1: Bridge #6069 and 6070 location map

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.

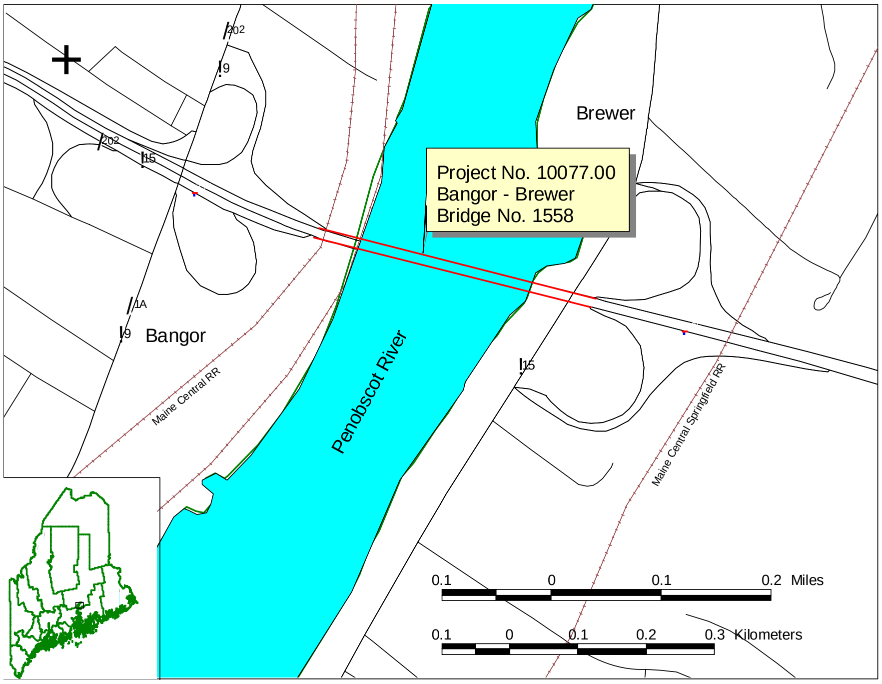

Figure 2: Bridge #1558 location map

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.

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 (\$0.51 yd^2)
9.5 NMAS Superpave		\$7.06 / m^2 (\$5.90 yd^2)
	Total	\$7.67 / m^2 (\$6.41 yd^2)
Resurface plus Waterproofing Membrane (estimated costs)		
Waterproofing Membrane		\$20.86 / m^2 (\$17.44 yd^2)
Bituminous Tack Coat		\$0.61 / m^2 (\$0.51 yd^2)
9.5 NMAS Superpave		\$7.06 / m^2 (\$5.90 yd^2)
	Total	\$28.53 / m^2 (\$23.85 yd^2)
Resurface plus High Performance Waterproofing Membrane (estimated costs)		
High Performance Waterproofing Membrane		\$32.69 / m^2 (\$27.34 yd^2)
Bituminous Tack Coat		\$0.61 / m^2 (\$0.51 yd^2)
9.5 NMAS Superpave		\$7.06 / m^2 (\$5.90 yd^2)
	Total	\$40.36 / m^2 (\$33.75 yd^2)
Resurface using Rosphalt 50 (bid price)		
Rosphalt 50 (Includes Royston 754 Tac-Coat and Edge Sealer 120-29)		\$38.16 / m^2 (\$31.91 yd^2)

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

Resurface Only (estimated costs)		
Bituminous Tack Coat		\$0.61 / m^2 (\$0.51 yd^2)
9.5 NMAS Superpave		\$10.62 / m^2 (\$8.88 yd^2)
	Total	\$11.32 / m^2 (\$9.39 yd^2)
Resurface plus Waterproofing Membrane (estimated costs)		
Waterproofing Membrane		\$20.86 / m^2 (\$17.44 yd^2)
Bituminous Tack Coat		\$0.61 / m^2 (\$0.51 yd^2)
9.5 NMAS Superpave		\$10.62 / m^2 (\$8.88 yd^2)
	Total	\$32.09 / m^2 (\$26.83 yd^2)
Resurface plus High Performance Waterproofing Membrane (estimated costs)		
High Performance Waterproofing Membrane		\$32.69 / m^2 (\$27.33 yd^2)
Bituminous Tack Coat		\$0.61 / m^2 (\$0.51 yd^2)
9.5 NMAS Superpave		\$10.62 / m^2 (\$8.88 yd^2)
	Total	\$43.92 / m^2 (\$32.72 yd^2)
Resurface using Rosphalt 50 (bid price)		
Rosphalt 50 (Includes Royston 754 Tac-Coat and Edge Sealer 120-29)		\$57.39 / m^2 (\$47.99 yd^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/m^2.

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.

Construction

Construction information such as mix design, construction procedures and photos, and verification test results will not be included in this report. Construction details can be reviewed in Technical Report 03-1, "Bridge Deck Resurfacing using Rosphalt 50", Construction Report, January 2003.

Evaluation

Visual observations and frictional resistance tests were utilized to evaluate the effectiveness of Rosphalt 50 as a concrete bridge deck wearing surface.

Visual Observations

All bridge decks were inspected on November 1, 2004 and October 4, 2006. Unfortunately there was no inspection in 2005.

Howland Bridge 6070

The wearing surface was in very good condition with no visible cracks. Average rut depths are < 6mm (<0.25 in). Construction joints are very well knit with no separation. Abutment edge seals and adhesion to granite curb and drains are very good.

In 2004 a spot of concentrated asphalt was observed at station 0+028 as is displayed in Photo 5. The spot is 0.5 meters (1.6 ft) long and 0.25 meters (0.8 ft) wide. There is no ravel or separation from the mat and its condition has not changed from 2004 to 2006.

Photo 5: Bridge # 6070 Surface Defect

Howland Bridge 6069

The overall condition of the wearing surface is very good and rutting is < 6 mm (0.25 in) in depth.

In 2004 a 2.2 meter (7.2 ft) portion of centerline joint near the south end of the bridge has separated. In 2006 the same centerline crack has increased in length to 14 meters (46 feet) and a width between 1 and 2 mm (0.04 and 0.08 in) as displayed in Photo 6. Normally this type of defect is of concern because it allows winter maintenance chemicals to penetrate and contaminate the RPCC bridge deck. In this case the bridge deck membrane was left intact when the original surface mix was milled then Rosphalt 50 was placed over the membrane. Unless the membrane is compromised the RPCC bridge deck should be protected.

There are roughly 30 areas of concentrated Rospahlt 50 that range in size from a quarter to a softball. The larger spots have begun to ravel to a depth of 12 mm (0.5 in) as displayed in Photo 7.

Material around drains and curbing is well sealed.

Photo 6: Bridge # 6069 Centerline Separation

Photo 7: Bridge # 6069 Surface Defect

Bangor – Brewer Bridge 1558

The wearing surface looks very good overall with an average rut depth of 6 mm (0.25 in).

Rosphalt 50 has begun to separate near the expansion joint in a number of areas. In 2004 about 10 percent of the bridge deck between the railroad and main bridge expansion joint in the east bound lane has separated to a width of 3mm (0.12 in). In 2006 about 50 percent of the same area has separated to a width of 6 mm (0.25 in) and as much as 10 mm (0.4 in) in a few areas as displayed in Photo 8. The east end of the bridge deck in the west bound lane started showing signs of separation in 2004. By 2006 90 percent of this area has opened up to a width of 3 to 4 mm (0.12 to 0.25 in). The west end of the bridge deck was well sealed in 2004; by 2006 there was slight separation in the passing lane only.

Photo 9 displays a portion of a 36 meter (118 foot) long section of centerline joint between the west bound travel and pass lanes that has opened up to a width of 3 mm (0.12 in). This would normally be a concern if the deck was surfaced with one layer of Rosphalt 50 but this bridge was surfaced with two 36 mm (1.5 in) lifts of Rosphalt 50 with an offset centerline. The first lift of material should protect the deck from winter chemicals unless the centerline crack penetrates both layers. The crack appears to be a result of poor construction.

There are a number of concentrated Rosphalt 50 areas in both lanes ranging in size from a quarter to a softball. The larger sized areas have raveled to a depth of 12 mm (0.5 in) in 2004 and remained the same in 2006 as depicted in Photo 10. Note also that the material is beginning to separate from the mat.

Another reason to seal the bridge deck with Rosphalt 50 was to reduce the amount of pavement shoving at the exit ramps. Over the four year period there has been no pavement shoving in these areas.

The seal around scuppers and granite curbing is in very good condition.

Photo 8: Bridge # 1558 EBL Expansion Joint Separation

Photo 9: Bridge # 1558 Centerline Separation

Frictional Resistance

Frictional resistance measurements were collected on September 23, 2004, October 5, 2005, and September 22, 2006. Frictional numbers range from a high of 65 to a low of 36. Average frictional numbers for all three bridge decks have decreased slightly in 2004 then remained about the same for 2005 and 2006. Table 1 contains a summary of frictional readings from 2002 to 2006. Mean frictional numbers continue to be nearly identical for the three year period for Bridge number 6070 and 6069 with values between a high of 59.3 and a low of 56.8. Bridge number 1558 has mean values between 50.4 an 48.0. Frictional resistance values on all bridge decks are well above the minimum mean frictional number of 35.

Frictional numbers in the travel lanes are 12 to 17 percent lower than the pass or ramp lanes. This is primarily due to increased traffic volumes and vehicle deposits such as oil and grease.

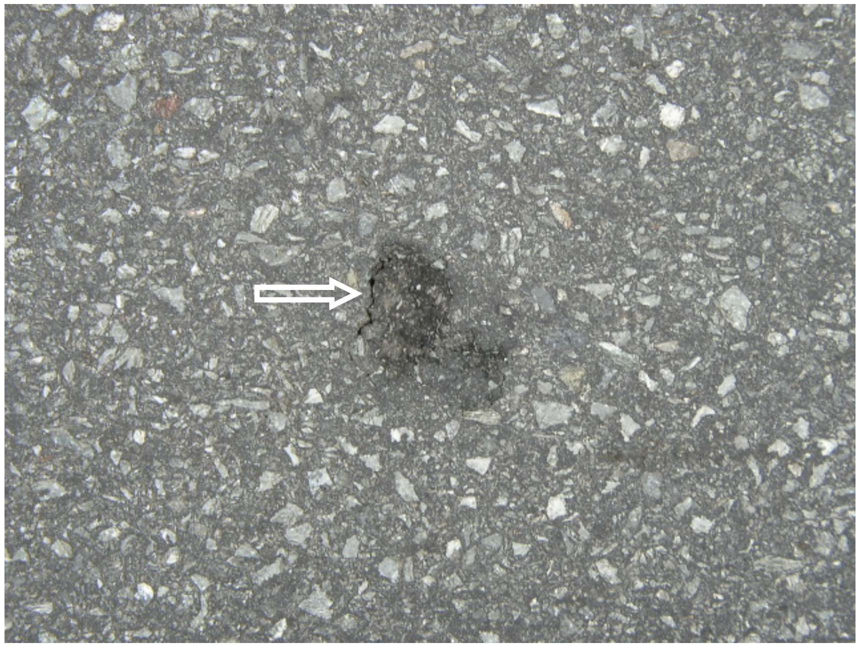

Photo 10: Bridge # 1558 Surface Defect

Table 1: Frictional Resistance Summary

	Howland Bridge # 6070				
Year	2002	2003	2004	2005	2006
Number of Tests	4	4	4	4	4
High FN	46	67	63	65	66
Low FN	40	55	50	50	55
Mean FN	43.0	60.3	56.8	58.3	59.3
Standard Deviation	2.58	6.18	6.24	6.24	4.99
	Howland Bridge # 6069				
Year	2002	2003	2004	2005	2006
Number of Tests	9	8	8	8	8
High FN	47	65	65	63	63
Low FN	35	55	54	56	53
Mean FN	41.8	60.5	58.5	58.4	58.8
Standard Deviation	3.99	3.66	4.24	2.39	3.49
	Bangor - Brewer Bridge # 1558				
Year	2002	2003	2004	2005	2006
Number of Tests	29	29	28	29	40
High FN	49	60	58	57	59
Low FN	36	43	40	36	40
Mean FN	43.1	51.2	48.0	48.3	50.4
Standard Deviation	3.76	5.69	5.26	5.92	5.18

Summary

Rosphalt 50 continues to perform as expected after four years exposure to traffic and the environment. Frictional resistance has stabilized to within normal readings. Rutting is minimal and Rosphalt 50 has eliminated shoving at exit ramps on the Bangor I-395 Bridge. Defective areas (concentrated asphalt spots) continue to be a concern and will be monitored closely for additional ravel and separation from the mat. Longitudinal joint separation and separation from the abutments is also a major concern. If the joint and abutment seal continues to separate it may allow winter maintenance chemicals to contaminate the RPCC bridge deck. It appears that these defects are a result of poor construction and concentrated Rosphalt 50 spots are a result of poor blending at the plant. Construction methods from plant to placement should be closely monitored to assure Rosphalt 50 properly seals the bridge deck.

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Additional Documentation:

TR 03-1 Construction Report, January 2003
TR 03-1 First Interim, December 2004