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MaineDOT

Transportation Research Division

Construction Report 11-02

NovaChip Pilot Project –Route 5,
Waterboro, Brownfield, & Fryeburg

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Table of Contents

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Introduction

In July & August, 2010, MaineDOT conducted experimental applications of NovaChip on 16 miles of highway in western Maine. Novachip is a proprietary pavement process that applies an ultrathin, gap-graded, hot mix wearing course over a polymer rich asphalt emulsion in one pass using a self-priming paver. The process quickly secures the NovaChip to the existing surface and allows for minimal traffic delays. The polymer rich asphalt emulsion migrates into existing cracks to seal and fill them. The asphalt emulsion bonds the NovaChip material to existing pavement. The placement operation moves along quickly using a specialized paver that places material directly behind the spray bar. A 10 ton steel roller follows the placement to seat the stone immediately after the placement.[1]

Selection of Trial Locations

The sections chosen for the NovaChip experimental were estimated to have good rideability, favorable IRIs and low rutting. The network data indicated that IRI values ranged from 50 to 140 inches/mile. The existing PCRs ranged from 3.2 to 4.2, and the rut depths ranged from 0.1 to 0.3 inches in either wheel path with 0.1 being the typical depth. All three trial sites are located on Route 5, specifically: Brownfield to Hiram (7.06 miles, beginning at the intersection of Denmark Rd/Depot St. And extending 7.06 mi to the intersection of Main St./Portland St.); Hiram to Brownfield (6.37 miles, beginning 0.11 of a mile north of the intersection of Main St./Pequawket Trail and extending 6.37 miles to the intersection of Denmark Rd./Depot St.); Waterboro (2.5 miles, beginning at Chadbourn Ridge Rd., extending 2.58 mi. to 0.22 mi from the Limerick/Waterboro town line). The corresponding project numbers are STP-1729(900)X, STP-1730(100)X, and STP-1730(300)X. These locations are shown on the two location maps on the next page.

[1] NovaChip Whitepaper, March 1, 2010 by Richard Crawford.

Figure 1. Brownfield to Hiram Section

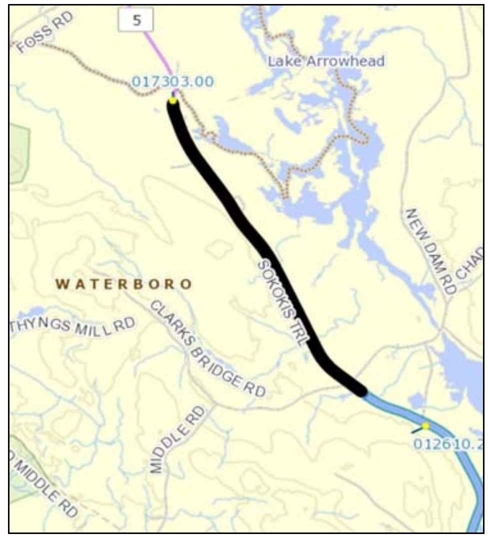


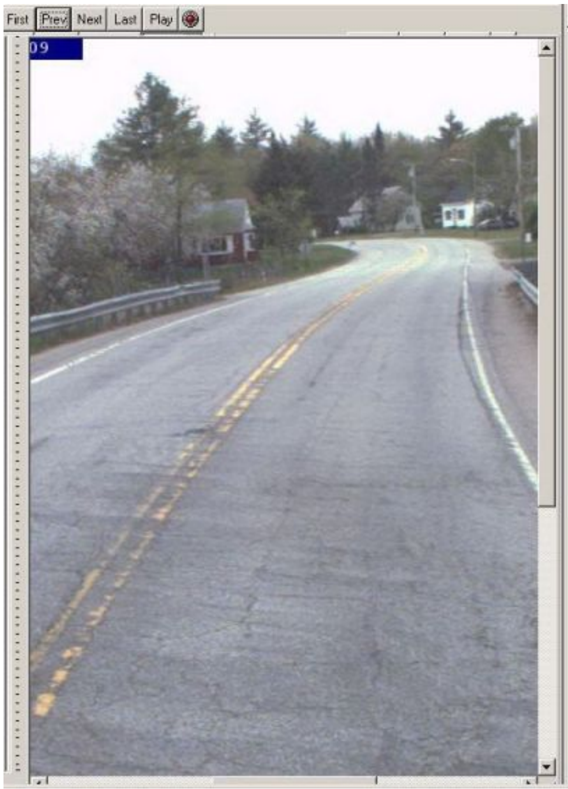
Figure 2. Waterboro Section

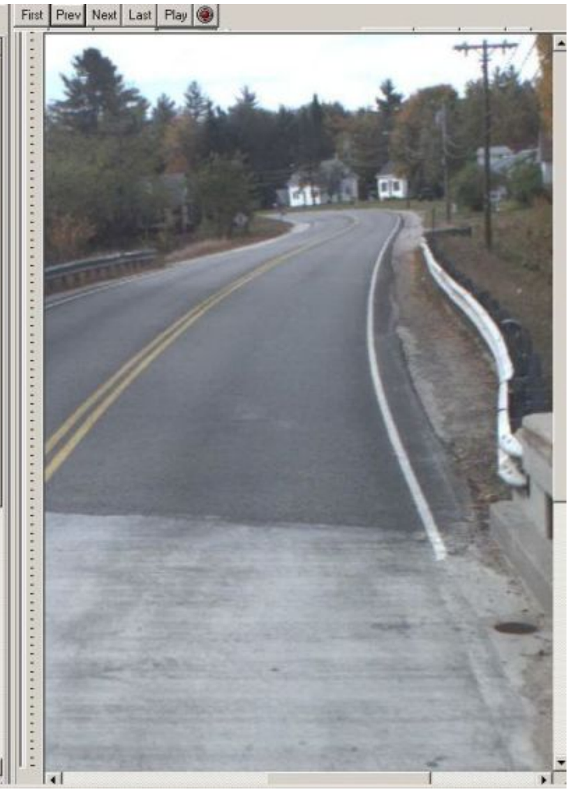
Crack Sealing & Shimming

Crack sealing and spot shimming with HMA were performed in advance of the NovaChip application. The 16 miles of highway required 4,000 gallons of crack seal, and 1,595 tons of shimming. In hindsight, more shimming could have been done. Future candidate projects with rutting and side drops, would need more shimming. On this project, however, due to the trial nature of the project, the contractor accepted this risk for additional material usage due to these factors.

Placement of NovaChip

The material and placement for this project was handled by a contract special provision. The special provision used for his project, (Section 462) is in Appendix A. The two photos below (as well as the two on the cover of this report show a before and after comparison.





Previous to this project, MaineDOT had used NovaChip only on Interstate projects. This rural two lane highway project was undertaken to gain experience with this promising technology and to determine how non-interstate applications would perform over time. This trial project led to some lessons learned that were not anticipated. These are listed in the following sections.

Road Shoulders

The contract did not incorporate shoulder treatments and corrections for the drop-offs in the shoulders. When it became apparent that additional shoulder rehabilitation was needed, MaineDOT's Maintenance & Operations crew did this work. The costs for shoulder gravel & additional work were not anticipated and do not appear in the project costs listed in this report.

Driveways & Side Roads

Previous experience with the Interstate NovaChip applications did not require consideration for side roads and intersections. On this Route 5 project, therefore no provision was made for tapering at intersections. On future projects a small amount of 3/8 inch asphalt mix could be used to hand taper at intersections and driveways. Planning for future projects should include the full range of conditions on the road sections, such as side roads, railroad intersections, deformed pavement sections, etc.

Atmospheric Conditions & Temperature

The weather conditions suitable for this treatment are more restrictive than with an asphalt overlay. Temperature is a critical factor. The polymerized tack coat must be hot in order to migrate into the overlay mix and bond it to the existing pavement. The asphalt emulsion has to remain fluid enough to soak into the hot mix asphalt wearing course in one pass. Cooler air temperatures could cool the emulsion too quickly and lead to unsatisfactory migration & bonding. Consequently NovaChip applications in Maine's climate should be limited to hot weather in mid-summer, e.g. June, July, August, and perhaps as late as the first week in September. This also means that placement at night probably should not be considered. Another observation was made that the NovaChip treated sections appeared dry after a rain event, however a fine mist, or road spray, was observed from the tires of passing vehicles. This is caused by moisture retained in small pockets in the open course mix. This phenomenon, raised a question about potential adverse effects from this water retention, for example, ice formation in the gap graded wearing course, or deterioration from freeze-thaw cycles. Future monitoring of these sections should include discussions with the winter maintenance crews to gather their observations.

Asphalt Spray

The working environment is a little different as compared with an HMA overlay. The paving crew near the machine wear breathing masks, because the hot asphalt spray creates droplets and vapors which are deposited on anything in very close proximity to the spray bar. This nuisance condition can create spatter droplets even a few feet away from the equipment.

Crack Seal

A crack sealing operation preceded the NovaChip application by, at most, a few weeks. This did not allow sufficient time for sealant to cure completely. Consequently, the sealant would bleed through after the NovaChip was placed. This effect can be seen where the impression of the underlying cracks can be seen on the surface of the wearing course. These extensively cracked areas should be observed during future monitoring for evidence of premature deterioration. Due to this problem, it has been suggested that an ideal schedule would have the crack sealing precede the NovaChip application by a full year. This would allow sufficient time for sealant curing in the cracks.

Butt Joints and Uneven Widths

The butt joint between lanes required special attention. The NovaChip machine cannot be widened, because the screed width is fixed. In comparison, an HMA paving screed can be extended or narrowed as needed. The NovaChip lane width is fixed, therefore any side movement of the equipment can cause gaps in the butt joint. In addition, the overlay is very firm because of the coarse asphalt mix. There was very minimal little knock down or movement of the overlay, when rolled by the steel roller. Consequently the joints required handwork with a propane torch and shovel to seal them. A similar situation occurred on curves where existing lanes may have moved outward over time. A better result might have been achieved if the paving equipment could lay down a wider lane on these irregular areas.

Spillage of Hot Mix Material

Unlike an asphalt overlay project, the spillage of HMA in front of the equipment flap, needs immediate attention by the crew to clean up. This is due to the fact this spillage will not be bonded with emulsion. This area could be a source of pavement delamination in the future. For this reason the skill of the crew, including machine operators, truck drivers, and hand crews is particularly important for this operation to proceed smoothly. On this project the contractor’s staff was adept and attentive to this because of their extensive experience with the process.

Site Selection for Future Novachip Applications

The selection of suitable roads for Nova Chip application will be critical. Roads that are too deteriorated, or too rutted should be eliminated from consideration. Rut depths are definitely a concern because excess rut depths will change the square yard coverage per ton of overlay material.

Project Costs

The total quantities and unit costs for this project are shown in the following table.

Butt Joints	610.00 sq. yds.	$9.00 per sq. yd.
Hot Mix Asphalt Shimming	1,595 tons	$90.00 per ton
Bituminous Tack Coat	1,395 gallons	$7.00 per gallon
Crack Sealer	4,000 gallons	$12.20 per gallon
Ultrathin Bonded Wearing Course	236,000 sq. yds.	$5.50 per gallon

Overall the project cost was around $1.7 million, which yields a total of $107,300 per mile.

Conclusions/Recommendations

This trial application was considered a success. Several lessons were learned that should be applied to future NovaChip trials. Specifically, more attention in advance should be given to shoulder treatment, driveways, intersections, side roads, additional handwork, material for butt joints, lay down width, atmospheric conditions, crack sealing, rut depths, broken pavement, and deformed areas. Site selection for future Novachip projects should factor in all of these items. In terms of operational planning, NovaChip treatment could be considered somewhat like a ¾ inch overlay project.

It was observed that the area in Waterboro had the best pavement to start with, whereas the areas towards Hiram & Fryeburg tended to be worse. These separate areas can be compared over time to see if performance varies between the Waterboro and Fryeburg section. The Waterboro area could be a control site for these performance differences. In addition, these sections should be compared in regard to overall pretreatment rut depths from ARAN data.

In addition, this project should be compared to a similar site having a ¾ inch HMA overlay having similar pavement characteristics, and completed during the same time frame. An excellent candidate site for this comparison would be the ¾ inch overlay completed on Route 4 between North Berwick and South Berwick. The Route 4 project could serve as a control site for comparison to the Route 5 NovaChip sections.

Monitoring Plan

The sections of highway treated with NovaChip will be monitored for performance over a five year period. Field visits and observations will be done. Analysis will include ride data from the ARAN data collection. If needed, subsurface investigations such as coring, and falling weight deflectometer (FWD) will be utilized in the event of premature failure. Observations from maintenance crews on snow and ice control on this surface will be noted. An interim report will be prepared after two years service and final report after five years.

Thanks to Rich Crawford, Tim Storer and John Macleod for assistance in developing this report.

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Appendix A

SPECIAL PROVISION
SECTION 462
GAP-GRADED HMA
(Ultra Thin Bonded Wearing Course)

DESCRIPTION The Ultra thin Bonded Wearing Course consists of a warm polymer modified asphalt emulsion tack coat followed immediately with an ultra-thin hot mix asphalt wearing course. The tack coat is spray applied immediately prior to the application of the wearing course to produce a durable wearing surface that can be opened to traffic. The finished surface treatment has a minimum thickness of 12.5mm, (1/2"), for Type A and 16mm, (5/8"), for Type B and Type C.

MATERIALS

The contractor shall formulate and submit to the Department, a job mix formula (JMF) that satisfies the design general limits listed in Table 1 – Mixture requirements. The production tolerances customarily used by the Department for HMA shall apply. The JMF range shall not fall outside the general design limits.

Table 1 – Composite Gradation

AASHTO Standard Sieve Sizes Total % Passing by Weight

METRIC	US	Type A ¼"	Type B 3/8"	Type C ½"
19 mm	¾"	-	-	100
12.5 mm	½"	-	100	85-100
9.5 mm	3/8"	100	85-100	45-85
6.3 mm	¼"	70-100	30-50	30-50
4.75 mm	#4	40-60	24-41	24-41
2.36 mm	#8	21-33	21-33	21-33
1.18 mm	#16	15-26	15-26	15-26
0.60 mm	#30	11-20	11-20	11-20
0.30 mm	#50	8-16	8-16	8-16
0.15 mm	#100	5-10	5-10	5-10
0.075 mm	#200	4-7	4-7	4-7
%PGB		4.9 – 5.4	4.8 – 5.3	4.8 – 5.3

*Note: All aggregate percentages are based on the total weight of the aggregate. The composite gradation for each individual Type of mixture shall meet the gradation requirements of table 1.

COARSE AGGREGATE

The single size coarse aggregate shall be nominal 6.3 mm (1/4”) for Type A, 9.5 mm (3/8”) for Type B, and 12.5 mm (1/2”) for Type C. These are recommended requirements only listed in Table 2 – Coarse Aggregate Gradations.

Table 2 – Coarse Aggregate Gradations

Total % Passing by Weight

Screen Size	A	B	C
12.5 mm, (1/2”)		100	85-100
9.5 mm, (3/8”)	100	85-100	25-80
6.3 mm, (1/4”)	60-100	0-15	0-15
4.75 mm, (#4)	10-45	0-3	0-3
2.36 mm, (#8)	0-3		
1.18 mm, (#16)			

Coarse aggregates used shall be from an approved source. Where coarse aggregates for these mixes are from more than one source or of more than one type of material, they shall be proportioned and blended to provide a uniform mixture.

FINE AGGREGATE

The fine aggregate shall be 100% crushed. These are recommended requirements only listed in Table 3 – Fine Aggregate Gradations.

Table 3 – Fine Aggregate Gradation

Screen Size	**% Passing**
4.75 mm, (#4)	**95-100**
2.36 mm, (#8)	**70-90**
1.18 mm, (#16)	**50-70**
0.60 mm, (#30)	**35-55**
0.30 mm, (#50)	**25-40**
0.15 mm, (#100)	**15-28**
0.075 mm, (#200)	**10-17**

AGGREGATES

Aggregates used shall be from an approved source and shall meet the requirements of section 703.07 for 3.0 to < 10 million ESALs except the changes or additions made by 1 through 7.

1. The Micro-Deval value shall 18 or less.
2. Absorption by AAHSTO T 85 shall be less than 2.0%.
3. It shall have a minimum sand equivalent of 45, (AASHTO T 176), and the fine aggregate shall be 100% crushed.
4. 95 % of the aggregate shall have at least a single face crushed and 85% shall have 2 or more crushed.
5. Aggregate shall have a maximum LA Abrasion of 35.
6. Percent by weight of Flat and Elongated particles shall be (5:1 ratio) with 10% maximum.
7. Soundness (AASHTO T 104-94) Magnesium Sulfate 18% maximum or Sodium Sulfate 12 % maximum.

MINERAL FILLER Hydrated lime, fly ash, baghouse fines and cement are acceptable as mineral filler.

Typical acceptable gradation: 100% passing 0.60 mm, (#30)
75-100% passing 0.075 mm, (#200).

ASPHALT BINDER Use PG 64-28.

TACK COAT Use grade CRS-2 asphalt emulsion modified with latex, natural or synthetic, and shall be certified as meeting the requirements of ASTM D2397 except as modified in Table 5 – Tack Coat Material Properties. It is required that the latex be co-milled at the bulk emulsion facility, to ensure complete and balanced blending.

Table 5 – Tack Coat Material Properties

Property	Method	Minimum	Maximum
Latex Content, % Mass of Total Residue		3.0	
Viscosity at 25 degrees C, (Sec.)	ASTM D244	20	100
Setting Time, Minutes	Observation	3	7
Demulsibility, % by wt. Residue	ASTM D244	40	

EQUIPMENT

PAVING The self-priming paver must be capable of spraying the tack coat, applying the hot asphalt overlay and smoothing the surface of the mat in one pass at the rate of 10-30 meters, (33-98 feet), per minute. The self-priming paver must incorporate a receiving hopper, feed conveyor, insulated storage tank for emulsion, metered tack coat spray bar and a variable width, heated, ironing type screed. The screed must have the ability to be crowned at the center both positively and negatively and have vertically adjustable extensions to accommodate the desired pavement profile.

COMPACTION Use steel wheeled double drum roller weighing at least 7.25 to 9 metric tons, (8 to 10 ton), that are equipped with functioning water systems and scrappers to prevent the fresh mix from adhering to the roller drums.

CONSTRUCTION DETAILS

SURFACE PREPARATION Contractor shall remove the striping and sweep the roadway as needed prior to surface the treatment.

APPLICATION The minimum pavement surface temperature for application of the tack coat and placement of the wearing course is 15º C, (60º F.). Apply the tack coat at a temperature of 60º - 70º C, (140º - 160º F.). Provide a uniform application across the entire width to be overlaid, at a rate of 0.68
– 1.13 liters per square meter, (.15 - .25 gallons per square yard). Continuously monitor the rate of spray. No equipment shall come in contact with the tack seal coat before the hot mix asphalt concrete wearing course is applied. Immediately after applying the tack coat, apply the hot mix asphalt overlay across the full width of the tack coat at a temperature of 150º – 165º C., (300º - 325º F.).

COMPACTION Begin compaction immediately after the application of wearing course. Use a minimum of two passes. The roller(s) will not be allowed to stop on the freshly placed wearing course. Use an adequate number of rollers to complete compaction before the pavement temperature falls below 85º C., (185º F.). Protect the wearing course from traffic until the rolling operation is complete and the material has cooled sufficiently to resist damage.

METHOD OF MEASUREMENT The Ultra Thin Bonded Wearing Course shall be measured by the square meter [square yard].

BASIS OF PAYMENT The accepted quantity of Ultra Thin Bonded Wearing Course will be paid for at the contract unit price per square meter [square yard], complete in-place which price will be full compensation for furnishing all equipment, material, labor and all incidentals necessary to complete the work.

Payments will be made under:

Pay Item	Pay Unit
462.30 - Ultra Thin Bonded Wearing Course	Square Meter [yd^2]