TOPS

Targeted Overlay Pavement Solutions

High-Performance Thin Overlays

March 2022

U.S. Department of Transportation
Federal Highway Administration

Every Day Counts
Innovation for a Nation on the Move

NOTICE

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QUALITY ASSURANCE STATEMENT

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15. Supplementary Notes: This is one of five case studies highlighting FHWA's Every Day Counts initiative known as Targeted Overlay Pavement Solutions (TOPS). TOPS integrate innovative overlay procedures into practices to improve performance, lessen traffic impacts, and reduce the cost of pavement ownership. FHWA Project Manager: Tim Aschenbrener; Principal Investigator: Shreenath Rao

16. Abstract: High-performance thin overlay (HPTO) mixture is a fine-graded polymer-modified asphalt mixture that uses aggregate with a top size of approximately ⅜ inch. It is designed using a modified Superpave design methodology with restrictions on the use of reclaimed asphalt pavement and sand. It is performance tested for rutting and cracking resistance during design and production. HPTO mixes are typically used in maintenance and pavement preservation applications but can also be used as a leveling course when extended staging times are expected for temporary pavements during construction. It is a rut-resistant and durable mixture most often placed at a thickness of 1 inch either on a milled or unmilled surface. HPTO has been used as a maintenance application on high-volume interstate projects and on heavy-duty parking lots.

The New Jersey Department of Transportation (NJDOT) has increasingly been using HPTO mixes for preventive maintenance and pavement preservation projects statewide. This report is a case study of NJDOT's experience and includes background, specifications, implementation, design, planning, construction, and performance.

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HIGH-PERFORMANCE THIN OVERLAYS

Overview

This is one of five case studies highlighting FHWA's Every Day Counts initiative known as Targeted Overlay Pavement Solutions (TOPS). The TOPS initiative integrates innovative overlay procedures into practices to improve performance, lessen traffic impacts, and reduce the cost of pavement ownership.

The New Jersey Department of Transportation (NJDOT) specifies high-performance thin overlay (HPTO) as a fine-graded polymer-modified asphalt mixture that uses 100 percent high-quality crushed stone with a nominal maximum aggregate size of 3/8 inch. HPTO is designed using a modified Superpave design methodology with restrictions on reclaimed asphalt pavement and natural sands. The typical lift thickness for HPTO is 1 inch.

NJDOT uses HPTO as a multi-solution tool but primarily as a preservation application on pavements in good to fair condition in need of minimal repairs (less than 10 percent). HPTO can be combined with other preservation strategies such as microsurfacing, slurry seals, or micro-milling as warranted by unique project conditions. NJDOT research shows the timing of HPTO application is critical to get the maximum pavement life extension. According to NJDOT, HPTO applied to existing pavement in “good” condition more than doubles the service life compared to HPTO applied to "fair" condition pavements.

Specification

The use of HPTO is not required by Federal law, nor are these specifications meant to bind the public in any way. NJDOT's HPTO specification includes the following provisions that give HPTO its characteristic qualities.

- Lab mixture performance testing occurs during mix design, test strip, and production.
- The resident engineer approves the test strip before production and placement.
- Performance tests include the asphalt pavement analyzer to measure rutting resistance, and the overlay tester to measure cracking resistance correlated with fatigue and reflective cracking.
- A material transfer vehicle is used to reduce thermal segregation and maintain consistent paving speed.
- Placement does not occur when the chance of rain is 50 percent or greater, or pavement temperature is below 50 degrees Fahrenheit.
- An engineer approves the underlying surface before placement.

Construction Characteristics

NJDOT has identified two key construction considerations.

- Understand the significantly reduced compaction window for thin 1-inch lifts.
- Use a compaction aid and observe rolling operations during test strips.

HPTO is NJDOT's most widely used pavement preservation treatment as shown in Table 1.

Table 1. NJDOT Preventive Maintenance 2008-2018

Treatment	Miles
High-performance thin overlay	944
Micro surfacing	405
Slurry seal	265
Ultra-thin friction course	193
Chip seal	59
Cape seal	55
Stone mastic asphalt thin overlay	30

Potential Benefits

According to NJDOT, HPTO provides the following benefits:

- Applies to state highway systems with high-traffic volumes.
- Improves ride quality depending on existing pavement conditions.
- Reduces noise and increases long-term skid resistance.
- Creates a renewed, sealed road surface to protect and extend pavement life.
- Minimally impacts traffic with short road closures.
- Extends pavement service life without raising profile grade by more than 1 inch.

NJDOT has not computed the overall HPTO benefit-to-cost ratio to date but anticipates it to be high despite HPTO being a costlier application. According to NJDOT, benefits such as life extension of pavement by approximately 10 years, minimal impact on traffic with short road closures, and reduced user costs and carbon emissions, outweigh the added cost of the treatment.

According to NJDOT, State performance mixture testing requirements, successful construction practices, and the resident engineer's prior approval in the specifications appear to have played a role in the success of HPTO as a pavement preservation tool.

"NJDOT's use of HPTO has increased service life and delayed resurfacing needs on several interstate projects with high-traffic volumes for flexible, rigid, and composite pavement types."

—NJDOT Supervising Engineer Robert Blight

BACKGROUND

In the late 1990s, a New Jersey contractor needed a heavy-duty thin-lift overlay for use in a parking lot. The contractor believed a typical parking lot mix would not provide the desired performance and reached out to an asphalt pavement technologist to inquire if such a product existed. This led to the development of the first HPTO concept. The mix performed well with time and was placed by the contractor in several other locations, such as municipal roads and parking lots (Fee 2021).

Parallel efforts were underway at Rutgers University to develop a thin-lift mixture for low-traffic volume pavements that could improve smoothness and structure and seal the existing pavement. It was modeled after New York State Department of Transportation's 6F (1/4-inch stone) mixture but used a polymer-modified PG 76-22 asphalt. The first HPTO draft specification was developed in March 2006. The mix was piloted on an asphalt refinery access road subject to heavy tanker traffic (Figure 1). The existing thin-section pavement had extensive cracking. However, despite undergoing no milling or pre-overlay repairs, the pavement had minimal reflective cracking one year after placement. At least one core extracted from the pavement revealed that, despite an existing crack, HPTO was effective in resisting reflective cracking (Figure 2) (Bennert 2021).

Figure 1. First-generation HPTO placement. Source: Dr. Tom Bennert

Figure 2. Core showing resistance to reflective cracking. Source: Dr. Tom Bennert

Shortly afterward, the global financial crisis of 2007-2008 disrupted infrastructure projects nationwide. State and local agencies sought to keep their road networks serviceable without the anticipated funding for typical rehabilitation projects. NJDOT needed an affordable and innovative solution to keep traffic flowing safely despite canceled rehabilitation projects statewide.

NJDOT led a team of design engineers, materials engineers, researchers, and asphalt suppliers to develop an overlay solution to fit the extreme circumstances. The team believed a polymer-modified binder was integral to success and developed a gap-graded mixture using polymer-modified asphalt binder, now known as HPTO, shown in Figure 3.

PAVEMENT PRESERVATION

In the early 2000s, NJDOT still used the approach of resurfacing pavements in "poor" condition first with little emphasis on pavement preservation in terms of funding and technology. Then in 2007, NJDOT adopted an asset management approach to program funding, creating dedicated funding for pavement preservation. Since then, NJDOT has developed and implemented a Transportation Asset Management Plan (TAMP). The NJDOT technology transfer website (NJDOT 2021) states that NJDOT has institutionalized design guidance, research, asset management systems, and funding for pavement preservation on state roadways.

Figure 3. HPTO paving (Top left). HPTO compaction (Top right). Finished HPTO surface (Bottom). Sources: Dr. Tom Bennert, NJDOT, and West Virginia Division of Highways

"NJDOT's pavement preservation program is a proactive approach to manage pavements and focuses on keeping pavements in good to fair condition and reducing the need for expensive repairs," said NJDOT Executive Manager of Pavement and Drainage Management and Technology Susan Gresavage, "HPTO is a core part of this proactive approach."

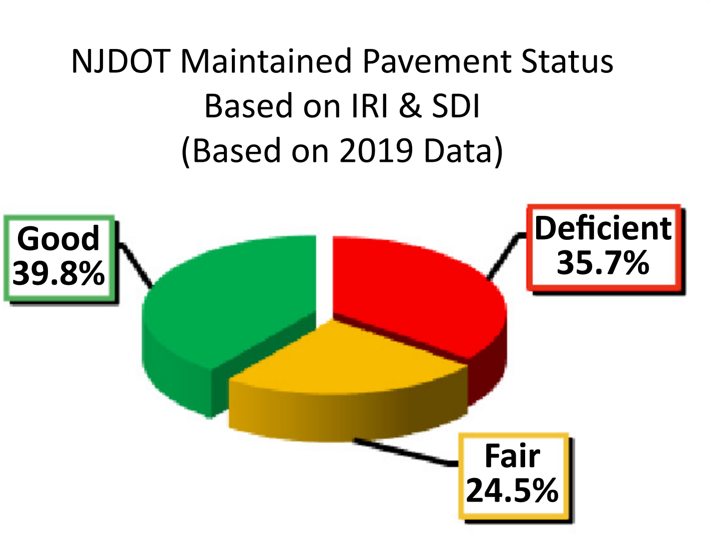

Figure 4. NJDOT 2019 pavement condition. Source: NJDOT

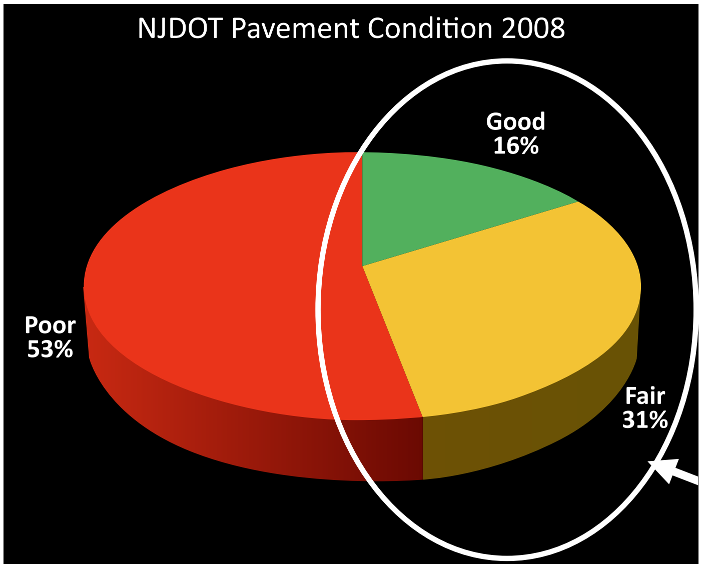

Figure 5. NJDOT 2008 pavement condition. Source: NJDOT

Figures 4 and 5 show an increase in pavements in good condition and an almost equal decrease in pavements in poor condition per NJDOT pavement rating standards between 2008—shortly after the start of the pavement preservation program—and 2019. These trends show that the pavement condition in NJDOT is improving. HPTO, one of seven NJDOT pavement preservation treatments, is one of the most expensive applications compared to other treatments such as chip seals, slurry seals, and microsurfacing. However, the high cost of $3 to $5 per square yard is easily offset by the benefits provided by the delayed need for resurfacing with a service life of about 10 years or more in some cases (Blight 2021).

The NJDOT pavement management system (PMS) tracked about 2,300 lane-miles of HPTO-surfaced pavements in the State highway system between 2012 and 2019 (Figure 6). Figure 7 shows an increase in preventive maintenance activities within the New Jersey State highway system and NJDOT's increasing use of HPTO since 2015 (Blight 2018).

NJDOT solves project challenges, such as compatibility with existing infrastructure and environmental needs, by developing and specifying asphalt mixes like HPTO. "We can't raise the elevations of our roads due to development and stream crossings which have created geometric constraints," said NJDOT Supervising Engineer Robert Blight. "We have to keep up with increased traffic demands without significantly adding thickness to our structures. This is another way HPTO benefits us."

Figure 6. NJDOT HPTO 2012 to 2019 map. Source: NJDOT

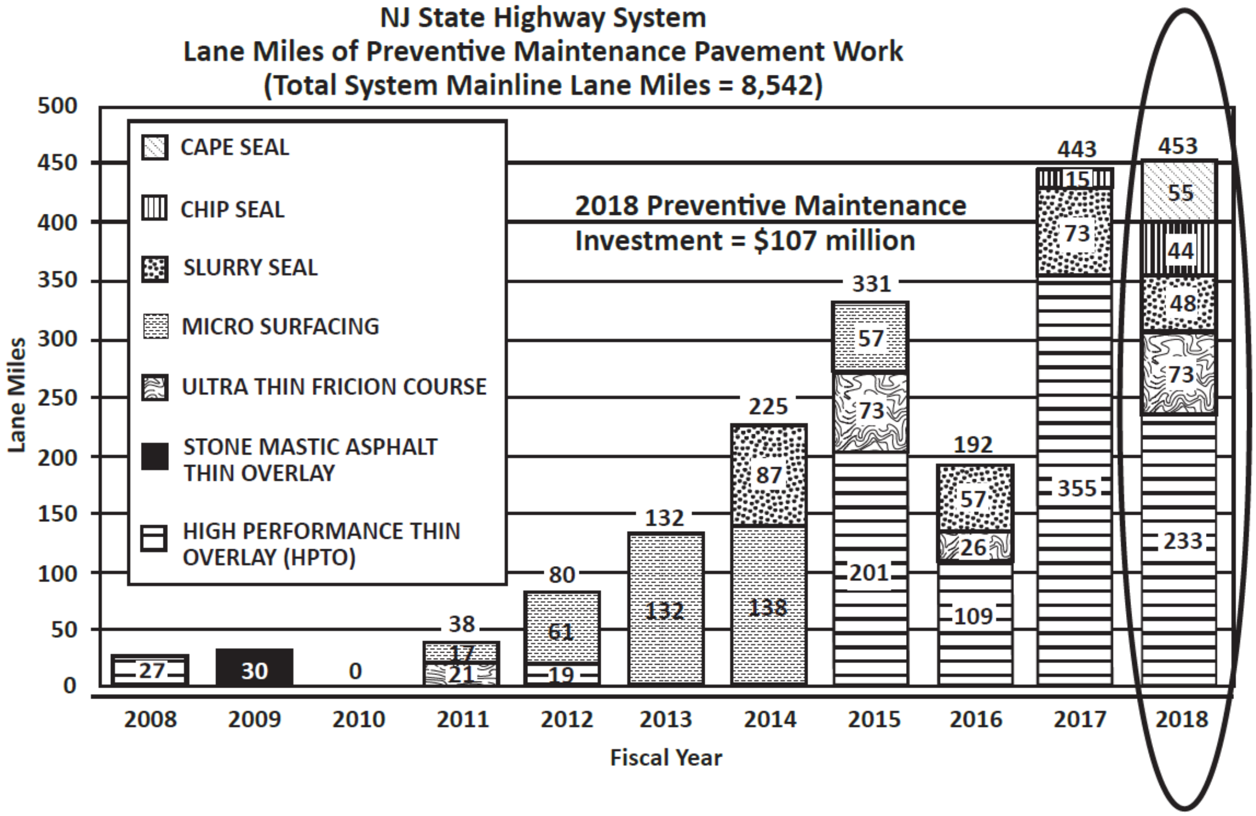

Figure 7. NJDOT preventive maintenance lane miles. Source: NJDOT

FOCUS PROJECT – INTERSTATE 287 (2008)

A project completed in 2008 on Interstate 287 (I-287) highlights NJDOT's first experience with HPTO. The southbound direction of I-287 in New Jersey, between mileposts 30.2 and 35.5, is reported to be a full-depth asphalt pavement. The section has three 12-foot lanes, a 12-foot outside shoulder, and a 4-foot inside shoulder (Bennert 2015, Bennert 2016a).

NJDOT uses a surface distress index (SDI) to categorize pavements as good, fair, or deficient. The NJDOT SDI scale ranges from 0 to 5, with 0 ratings assigned to pavements in the poorest condition based on rutting and surface cracking (Bertucci 2009). After an SDI data quality control review, the existing pavement condition on I-287 was rated as fair-good with an SDI of 3.0, an average international roughness index (IRI) of 76 inches per mile, and an average rut depth of 0.2 inches. An SDI of 2.4 or below triggers a need for rehabilitation in the NJDOT PMS.

A conventional dense-graded hot mix asphalt (HMA) overlay consisting of a 2-inch mill and overlay placed in 2000 was 8 years old and exhibited low severity top-down longitudinal fatigue cracking. In 2008, this section was selected as a candidate for the recently developed HPTO overlay. The transitions at the beginning and end of the project were milled 1 inch to match the existing elevation. A 1-inch-thick overlay was placed on the driving lanes. The right and left edges of the overlay were feathered into the existing inside and outside rumble strips. A hot-applied tack coat (PG 64-22) was specified to ensure adequate bonding to the existing surface. The SDI improved to a 5.0 immediately after the overlay.

The HPTO overlay did not significantly improve IRI (average IRI after overlay was 86 inches per mile) on this project. However, there were no ride quality requirements or incentives for the contractor to meet since this was a pilot project. The contractor did not use a material transfer vehicle (MTV) to optimize seamless paving and smoothness (Blight 2021). Ride quality improvements typically depend on pretreatment conditions and the extent to which they are addressed. However, NJDOT learned that including ride quality requirements on HPTO projects incentivizes the contractors to implement tools to improve ride quality, such as using MTVs, which the agency said also provides better construction quality. NJDOT reported that the section continued to perform well for 6 years without significant SDI reduction.

OTHER EXAMPLE PROJECTS

The following provides brief examples of how NJDOT uses HPTO as a targeted overlay on various pavement types and in combination with other treatments to improve pavement performance. All examples are based on information provided by NJDOT.

HPTO with a Micro-Mill on Rigid Pavement – Rt. 70 Cherry Hill

The existing surface of Route 70 at Cherry Hill had numerous HMA repairs throughout the project. The existing pavement structure was over 8 inches of joint reinforced concrete pavement (JRCP) with microsurfacing. Before HPTO, the SDI was 1.58 and the IRI was 269 inches per mile. The design 20-year equivalent single axle loads (ESALs) were approximately 20 million. The preservation strategy included a 1-inch micro-mill of existing surface course, additional 1/4" of JRCP, and a 1-inch HPTO application using a spray paver. Necessary repairs were performed before HPTO placement. NJDOT considers HPTO for preservation projects on pavements with up to 10 percent pre-overlay repairs. Proper repairs, micro-milling, and a successfully placed HPTO overlay provided a significant improvement in smoothness with a delivered IRI of 76 inches per mile (72% reduction in IRI). After 4 years, the pavement was still in good condition with a reported SDI of 4.5 and an IRI of 90 inches per mile.

HPTO with Microsurfacing on Composite Pavement – I-287 Piscataway

The existing pavement structure on I-287 in Piscataway consisted of 5 inches of HMA over 10 inches of JRCP. The existing SDI was 1.46, and the IRI was 110 inches per mile. The projected 20-year ESALs were more than 50 million. Pre-overlay repairs using HMA were performed, and microsurfacing was placed before the 1-inch thick HPTO application for pavement preservation. After 6 years, the pavement was still in good condition, with an SDI of 4.0 and an IRI of 81 inches per mile.

HPTO on Full-Depth Asphalt Pavement – I-295 Logan Township

The existing structure of I-295 in Logan Township consisted of full-depth HMA with an SDI of 3.45 and an IRI of 87 inches per mile. In 2008, the projected 20-year ESALs were more than 75 million. Pre-overlay repairs using HMA were performed, and the top 1 inch was milled from the existing pavement before the 1-inch HPTO application. In 2019, the HPTO overlay was still in good condition with an SDI of 4.0 and an IRI of 87 inches per mile.

SPECIFICATIONS AND IMPLEMENTATION

HPTO was the first specification in New Jersey requiring performance testing during design and production. The specification included use of the asphalt pavement analyzer (APA) to predict rutting performance. The APA is a loaded wheel test with an environmentally controlled chamber capable of testing samples in dry or submerged conditions. NJDOT uses gyratory specimens compacted at an air void content of 5.0 ± 0.5 percent for APA testing. To get an approved mix design, NJDOT requires APA rut depth results of less than 4 mm using 8,000 loading cycles when tested at 64 degrees Celsius with a hose pressure of 100 psi and 100-pound wheel load (NJDOT 2018). NJDOT's production requirements allow up to 5 mm before triggering price disincentives.

Cracking performance is predicted using the overlay tester, an electro-hydraulic system that applies repeated cyclic direct tension loads to specimens to estimate fatigue or reflective cracking susceptibility. NJDOT's mix design requirements test five specimens but discard the high and low results. The average of these three samples must reach 600 cycles before failure to meet NJDOT's mix design requirements.

For a HPTO mixture, high-quality 3/8-inch nominal maximum aggregate size aggregate with polymer-modified asphalt binder, typically PG64E-2 is currently specified. The gradation band with minimum asphalt content is shown in Table 2.

Table 2. NJDOT - HPTO volumetric requirements for mixture design.

Sieve Sizes	Percent Passing[1]	Production Control Tolerances[2]
3/8"	100	±0.0%
No. 4	65-85	±4.0%
No. 8	33-55	±4.0%
No. 16	20-35	±3.0%
No. 30	15-30	±3.0%
No. 50	10-20	±2.0%
No. 100	5-15	±2.0%
No. 200	5.0-8.0	±1.0%
Asphalt Binder Content (Ignition Oven)[3]	7.4% minimum	±0.30%

[1]Aggregate percent passing to be determined based on dry aggregate weight.

[2]Production tolerances are for the approved JMF and may not fall outside of the wide band gradation limits.

[3]The asphalt binder content may not be lower than the minimum after the production tolerance is applied.

Other NJDOT mix design requirements include a minimum void in mineral aggregate of 18.0 percent for improved fatigue resistance (NJDOT 2018), dust to binder ratio limits, and draindown thresholds. These mixture design and volumetric requirements during mix design and production are shown in Table 3.

Table 3. NJDOT - HPTO volumetric requirements for control.

Project Phase	Required Density (percent of maximum specific gravity): Ndes (50 gyrations)	Required Density (percent of maximum specific gravity): Nmax (100 gyrations)	Voids in Mineral Aggregate	Dust to Binder Ratio	Draindown AASHTO T 305[1]
Mixture Design	96.5	≤99.0	≥18.0 percent	0.6 – 1.2	≤0.1 percent
Production Control	95.5 – 97.5	≤99.0	≥18.0 percent	0.6 – 1.3	≤0.1 percent

[1]AASHTO T 305 is not a Federal requirement.

Table 4 shows NJDOT's HPTO mixture performance requirements along with the percent pay adjustment criteria for production and placement. The construction specifications for HPTO include additional NJDOT pay requirements for ride quality and compaction.

The NJDOT specification also includes the mandatory use of MTVs to prevent frequent paver stops due to delayed transport trucks and/or thermal segregation, requiring static rolling if aggregate breakdown or bleeding of asphalt is observed in vibratory mode, surface preparation requirements, and allowing warm mix asphalt for applications in cooler weather. Strict weather limitations state that HPTO should not be placed if the National Weather Service forecasts a 50 percent or greater chance of rain during the scheduled placement. Another NJDOT requirement is that the contractor and resident engineer must coordinate before placement to ensure the existing conditions of the underlying surface have been adequately addressed (NJDOT 2018).

Table 4. NJDOT - HPTO performance testing pay adjustments.

Test	Requirement	Test Result	PPA
APA at 8,000 loading cycles, mm (AASHTO T 340)	5.0 maximum	$t \leq 5.0$ $5.0 < t \leq 12.0$ $t > 12.0$	0 -50(t-5)/7 -100 or remove and replace
Overlay Tester, cycles (NJDOT B-10)	600 minimum	$t \geq 600$ $600 > t \geq 400$ $t < 400$	0 -(600-t)/4 -100 or remove and replace

NJDOT's HPTO specifications are continuously improved by adding revised material specifications and construction practices such as a bond strength requirement to evaluate tack coat application (Blight 2018). Other specification evolutions have occurred since the inception of HPTO. For example, challenges were encountered during the binder specification transition from performance-graded to multiple stress creep recovery. Research efforts determined the challenges were related to new binder grades, not the HPTO specification, and were addressed by modifying the binder specification (Bennert 2021).

DESIGN AND PLANNING

23 U.S.C. §116 defines pavement preservation as "programs and activities employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety, and meet road user expectations." According to Guidance on Highway Preservation and Maintenance, an FHWA memorandum issued in February 2016, pavement preservation treatments restore the overall condition of the pavement and generally do not add structural capacity.

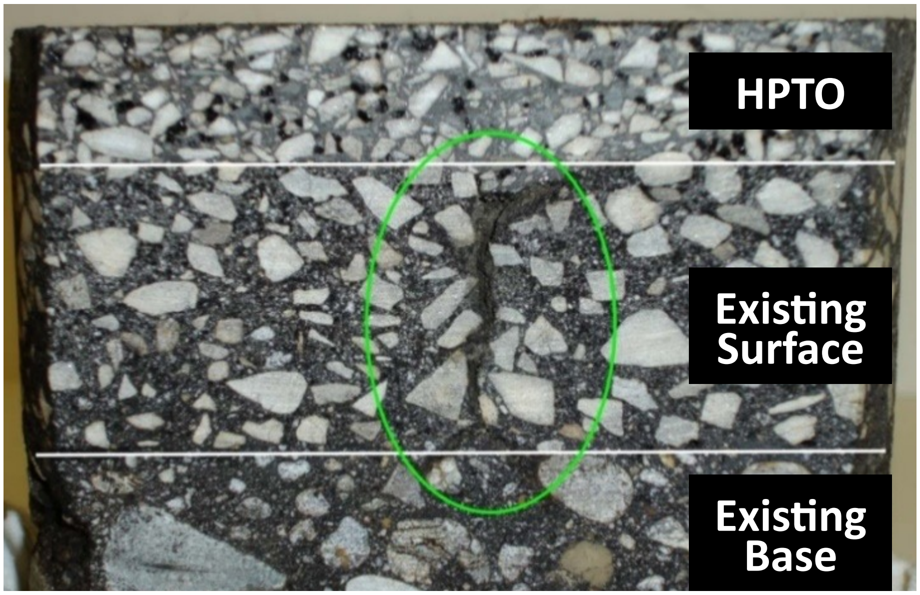

Figure 8. NJDOT - HPTO resistance to low severity cracking.
Source: Dr. Tom Bennert

NJDOT typically selects HPTO as a surface treatment for existing pavements with low to moderate severity distress without milling or crack sealing. However, HPTO can be combined with other preservation strategies such as microsurfacing, slurry seals, or micromilling to meet unique project conditions. Well-bonded and successfully placed HPTO has shown resistance to the reflection of low severity cracking. Figure 8 shows an existing HMA base and surface courses with an HPTO overlay that shows resistance to low severity cracking.

NJDOT assesses pavements in fair condition with moderate severity distresses to determine a treatment combination. For example, the agency pairs HPTO with milling to improve IRI, repair minor ruts, seal cracks, and repair other moderate distresses. NJDOT generally limits repairs to 10 percent of the preservation project.

NJDOT has found using HPTO as an interlayer in an overlay system is beneficial when staged construction is needed. Because HPTO provides resistance to rutting and cracking, along with surface friction, NJDOT uses the product as a leveling course when the roadway is subject to traffic loads before HPTO placement.

Other considerations at a project's planning stage may include resetting, recasting, or reconstructing inlets, manholes, curbs, and driveways as needed. Warm mix asphalt can be specified to achieve adequate compaction on projects that extend into the colder months.

CONSTRUCTION

According to NJDOT, the success of HPTO requires high construction standards. Construction considerations should include the existing pavement condition and the repair activities needed before HPTO placement to achieve a well-bonded, adequately compacted, smooth surface.

HPTO typically consists of coarse aggregate, fine aggregate, and asphalt binder. Mineral filler or asphalt binder additives such as warm mix additive may be included as necessary. Use of any recycled materials and certain aggregate types is not permitted. Minor adjustments to crusher plants producing the necessary aggregate gradations that meet the fine-graded HPTO specifications may be needed.

NJDOT's specification requires an MTV to reduce thermal and end-of-load segregations during placement. HPTO can be placed using a conventional or spray paver, also known as an ultra-thin paver, which combines a tack distributor and paving machine. Local contractors have successfully used both machines to attain good tack application and bond strength, which are critical for thin lifts. Compaction is performed with standard double drum vibratory rollers. However, if the breakdown of aggregate or bleeding of asphalt binder is observed, NJDOT's specification requires rolling operations be performed in static mode only.

A test strip is required for all NJDOT HPTO projects so the construction team can better understand mixture behavior during placement.

With the high asphalt content and a relatively thicker film, a newly constructed HPTO surface may have a lower initial skid resistance until subject to surface wear due to traffic. In such cases, a light application of sand on the newly placed surface to improve initial skid numbers is considered a solution (Blight 2018).

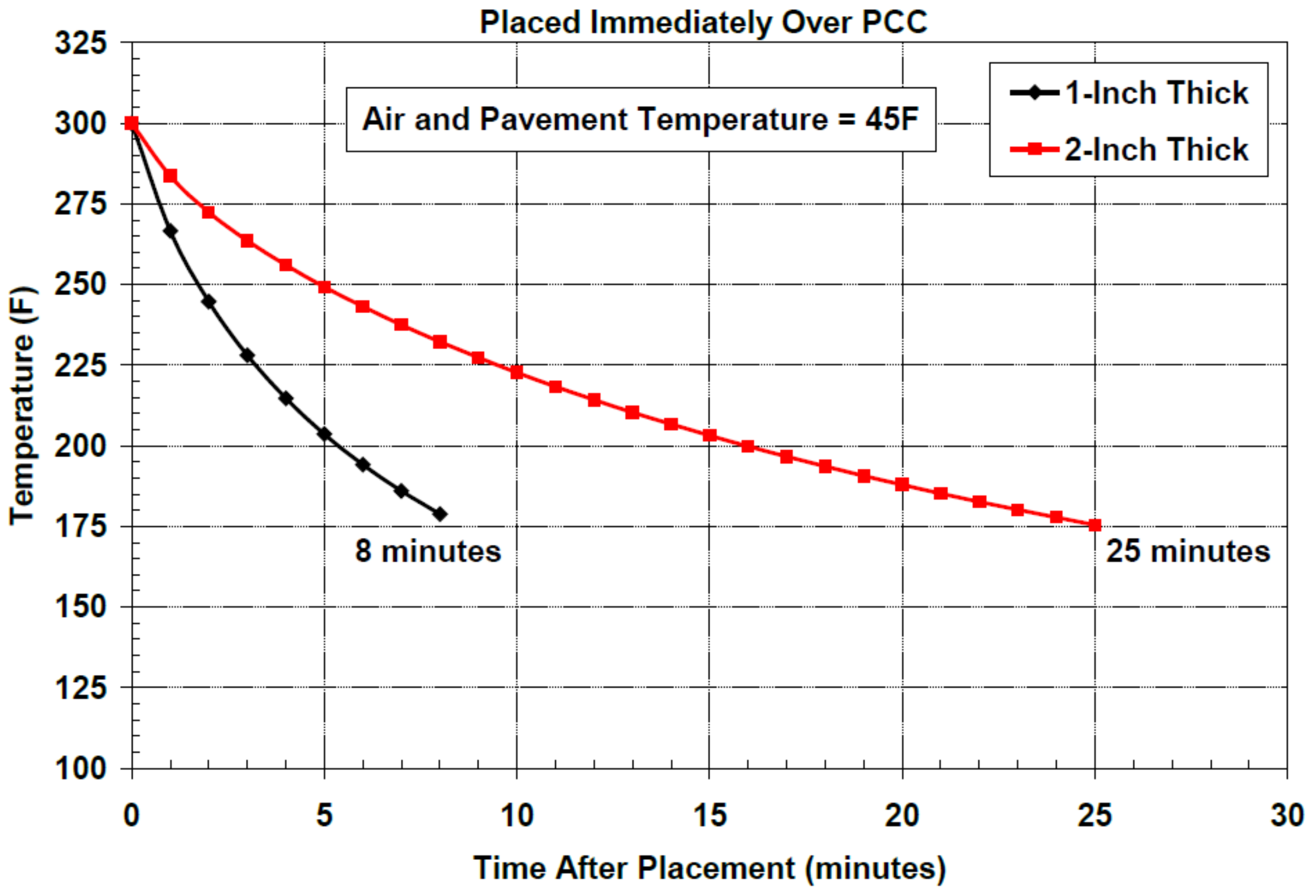

Figure 9. Example analysis for general thin-lift HMA cooling using a free software tool.
Source: Presentation by Dr. Tom Bennert

When using micromilling during repairs prior to overlay, identifying and removing areas with asphalt scabbing and any unsound material will help improve overlay performance (Blight 2021). Using the appropriate spreading rate for the tack coat and achieving 100 percent coverage is critical to ensure the HPTO bonds well with the existing surface particularly because of the limited time for compaction of a 1-inch lift compared to conventional thicker lifts. Free tools can be used to predict available compaction time (Figure 9). NJDOT has found success increasing compaction times using warm mix asphalt when paving during cooler months.

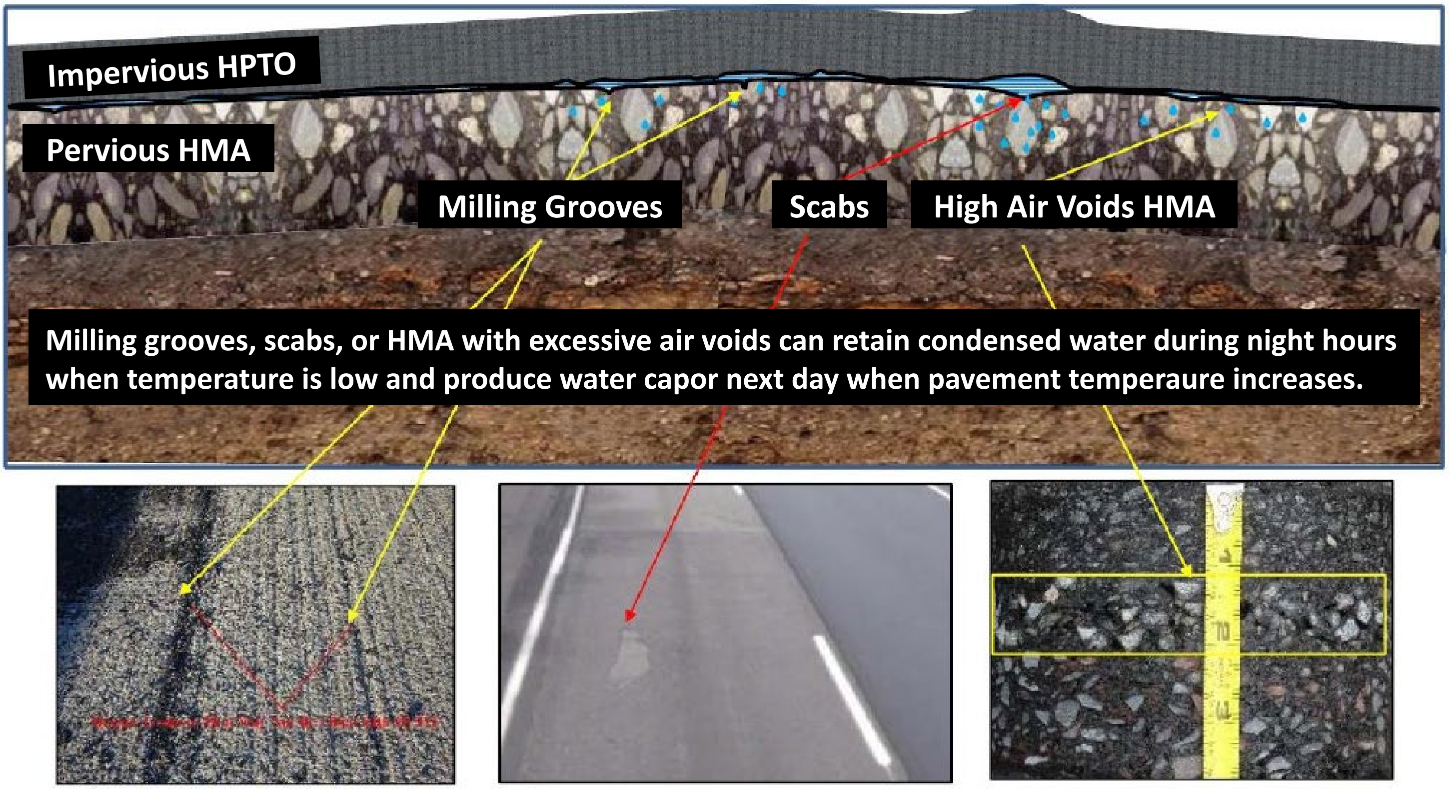

Figure 10. HPTO blistering. Source: NJDOT

Pavement should be dry and clean before placing HPTO. “One of the challenges we encountered on some HPTO projects was blistering,” said Blight. “We found that blisters are generally related to inadequate quality control during HPTO placement and not using successful construction practices. We are working with industry on some revisions to the specifications to see if it resolves the issues.” The blistering seen in some NJDOT projects is caused by trapped water vapor. Figure 10 shows that milling grooves, scabs, or HMA with excessive air voids can retain condensed water during night hours when the temperature is low and produce water vapor the next day when the pavement temperature increases.

Water gets trapped beneath the impervious HPTO and pervious underlayer. Blistering occurs when the warming daytime temperatures convert the trapped water into vapor.

To reduce blistering, NJDOT recommends improving quality assurance procedures during milling, production, and placement, such as proper sweeping, cleaning, and drying the pavement before overlay. Intelligent compaction implementation is being considered to monitor compaction efforts in real-time and document construction quality. Mix design changes that increase permeability without compromising beneficial HPTO characteristics may be considered.

PERFORMANCE AND EVALUATION

HPTO performance as a pavement preservation treatment in New Jersey has been studied since the first official project in 2007. It is considered an effective solution that provides a crack- and rut-resistant surface to extend pavement life and cause minimal impact on road users and the environment during construction.

Rutgers University summarized the performance of 10 HPTO sections using NJDOT PMS data (Bennert 2018). The pre-existing pavement condition before overlay was used to categorize the projects. The first category included pavements with an SDI greater than 2.4 before overlay. The second category included pavements with a pre-overlay SDI of less than 2.4. Sections with pre-existing SDI of less than 2.4 provided an average service life of 5 years. “Service life” is the number of years in which the pavement is still considered to be in good to fair condition (SDI<2.4). When HPTO was placed on the pavement with an existing SDI>2.4, service life trended towards 13 years (Figure 11). Therefore, the preservation benefits when the pavement is still considered to be in “fair to good” condition are nearly twice that of pavements with more surface distresses.

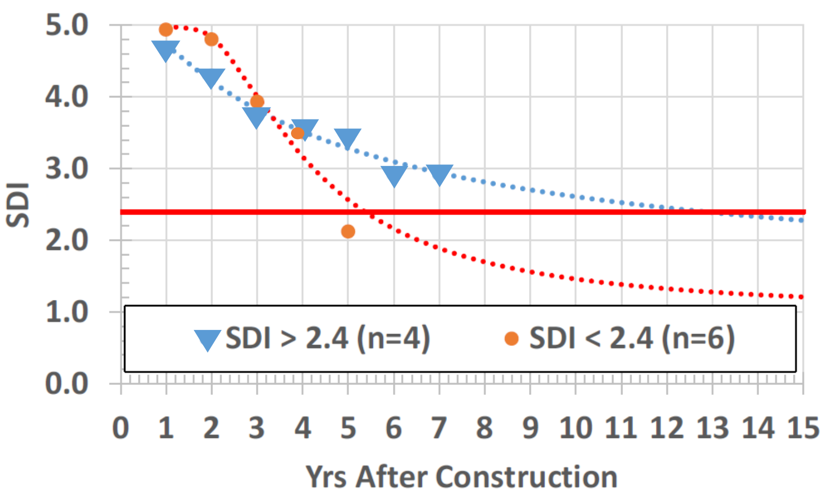

Figure 11. NJDOT PMS analysis of HPTO sections. Source: Dr. Tom Bennert

The cost per ton of HPTO is higher, but it is an inch thinner than typical dense-graded mixes. Therefore, an agency can get more coverage with HPTO. The contractor can also get in and out much quicker with HPTO because production for a 1-inch lift is much faster. Reduced traffic delays on NJDOT’s congested roads are also a huge consideration when evaluating costs (Bennert 2021).

NJDOT strictly enforces paving windows from 9:00 pm to 6:00 am, so increased production is essential. Crude cost calculations show HPTO outperforms dense-graded mixes, although it is difficult to directly compareperformance and rehabilitation treatments.

Originally, safety was a big concern for NJDOT, and the thought was the finer aggregate and higher asphalt content would make the surface mix more prone to skidding. Early on, skid numbers (SN40) were measured regularly using a skid trailer. The resulting skid numbers on NJDOT HPTO were as good as or better than other dense-graded mixes and were satisfactory on most NJDOT roads (Bennert 2021).

HPTO is reported to perform well on composite pavements and effectively delay reflective cracking (Blight 2021). However, HPTO performance is dependent on sound planning, design, materials, and successful construction practices. NJDOT has generally found that 1-inch HPTO preservation treatments perform as well as or better than resurfacings such as “mill 2-inch and pave 2- inch” HMA strategies used in the past (Blight 2018).

SUMMARY

By including HPTO in its pavement preservation program, NJDOT has improved program effectiveness and increased the percentage of network pavements in “good condition” while reducing pavements in “poor” condition. Other benefits include increased life of pavement sections with high-traffic volumes, improved ride quality, decreased noise, and long-term skid resistance.

HPTO, when applied to “good” condition pavement, more than doubles the service life compared to HPTO applied to fair condition pavements (Bennert 2016).

The overall HPTO benefit-to-cost ratio, though not computed to date, is anticipated to be high despite HPTO being an expensive application relative to other preservation treatments. Benefits such as life extension of pavement by approximately 10 years, minimal impact on traffic with short road closures, reduced user costs, and reduced carbon emissions outweigh the added cost of the treatment.

HPTO provides solutions to NJDOT’s design concerns by minimizing changes to the vertical clearance at overpasses and matching the elevation of infrastructures such as guardrails, curbs, and gutters while keeping up with traffic demands. HPTO is also a solution at protected stream crossings where environmental regulations do not allow elevation changes.

Performance mixture testing requirements, successful construction practices, and requiring the resident engineer’s approval before paving appear to have played a role in the HPTO success as a pavement preservation tool.

LIST OF ACRONYMS

- **APA** asphalt pavement analyzer
- **ESAL** equivalent single axle load
- **FHWA** Federal Highway Administration
- **HMA** hot mix asphalt
- **HPTO** high-performance thin overlay
- **IRI** international roughness index
- **JRCP** joint reinforced concrete pavement
- **MTV** material transfer vehicle
- **NJDOT** New Jersey Department of Transportation
- **PMS** pavement management system
- **SDI** surface distress index

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