

**BEST PRACTICES
FOR
ARCHITECTURAL PAVEMENT TREATMENTS**

Final Report

Prepared for

**THE NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT
AUTHORITY**

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Abstract Architectural Pavement Treatments are special treatments applied to pavements to enhance the aesthetic character of the pavement and the surrounding environs in which they are applied. They achieve this objective by imparting special colors and/or patterns to the roadway, typically applied at crosswalk locations, traffic circles to highlight and delineate the selected areas. This report presents the findings and conclusions of an evaluation of the design and construction procedures and the performance of Architectural Pavement treatments on New York State roadways. Three categories of treatments were considered in the evaluation. They include Textured Thermoplastic Inlays, Textured Hot Applied Polymer Surface and Epoxy/Polymer Binder. The evaluation was undertaken through surveys of vendors/suppliers of the treatments, surveys of State and local government agencies that previously used these treatments, surveys of selected New York State sites, where the treatments have been employed and a review of existing specifications. Based on the results of the investigation a Best Practice Guideline was prepared and is included as an Appendix to this report.					
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ABSTRACT

Architectural Pavement Treatments are special treatments applied to pavements to enhance the aesthetic character of the pavement and the surrounding environs in which they are applied. They achieve this objective by imparting special colors and/or patterns to the roadway, typically applied at crosswalk locations, traffic circles to highlight and delineate the selected areas. This report presents the findings and conclusions of an evaluation of the design and construction procedures and the performance of Architectural Pavement treatments on New York State roadways. Three categories of treatments were considered in the evaluation. They include Textured Thermoplastic Inlays, Textured Hot Applied Polymer Surface and Epoxy/Polymer Binder. The evaluation was undertaken through surveys of vendors/suppliers of the treatments, surveys of State and local government agencies that previously used these treatments, surveys of selected New York State sites, where the treatments have been employed and a review of existing specifications. Based on the results of the investigation a Best Practice Guideline was prepared and is included as an Appendix to this report

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Summary

Objectives

The objective of the study was to evaluate design and construction procedures and the performance of architectural pavement treatments used on New York State roadways. A secondary objective was to develop a Best Practice Guideline that could be used by designers and field inspectors responsible for the application of such treatments in New York State, and provide recommendations to improve current NYSDOT implementation procedures.

Research Approach

To achieve the aforementioned objectives, the Research Team undertook several tasks. These included a review of architectural pavement treatment literature, surveys of vendors/suppliers of the treatments and surveys of State and local government agencies that had previously used the treatments. Field surveys were also conducted. These included two site visits to 21 installations, over a period of two winter seasons, to examine the durability of each treatment type exposed to a number of traffic conditions. Performance and service life projections were developed by canvassing other user agencies, and the development of a simplified linear regression model to provide projections of the expected service life of each treatment.

Analyses and Results

The analysis and results were used to prepare a Best Practice Guideline. The document provides comprehensive description of each of the referenced treatments including information on expected performance (treatment life), installed costs, materials and equipment used in the process, and construction and inspection procedures that are typically employed when specifying the use of such treatments.

Conclusions and Recommendations

It was concluded that Architectural Pavement Treatments can be expected to perform satisfactorily and effectively for several years, given reasonable traffic volume and the employment of proper design and installation procedures, however to ensure satisfactory performance a number of recommendations were made. These recommendations included the establishment of an approved list of Architectural Pavement Treatments, based on trial test periods similar to methods used by Florida DOT, and the development of criteria to define when a treatment has reached the end of its functional service life. It was also recommended that a mechanism be established to continue to track existing treatments to obtain better long-term data that could be used to more accurately project service lives. Additionally it was recommended that selected specification changes in existing NYSDOT specifications be made regarding high points on pavement surfaces and potential snowplow damage, and minimum friction requirements for aggregates used in such treatments.

Introduction

Architectural Pavement Treatments are special treatments applied to pavements to enhance the aesthetic character of the pavement and the surrounding environs in which they are applied. They achieve this objective by imparting special colors and/or patterns to the roadway, typically applied at crosswalk locations, traffic circles to highlight and delineate the selected areas.

These treatments have been frequently used by NYSDOT in conjunction with local municipalities to enhance the attractiveness of downtown areas and as a tool to improve pedestrian safety at roadway crossings. Treated crosswalks have a secondary energy-related benefit. They encourage walking by school children and shoppers and thereby reduce the use of vehicles and the fuels required to power them. Traditionally, such applications were installed using clay brick pavers, granite pavers or Portland cement concrete. For various reasons these traditional methods have been dropped and modern materials substituted. Today, synthetic, plasticized surfaces in the form of thermoplastic inlays, polymer surfaces, and epoxies are widely used in these applications.

Despite the current use of architectural pavement treatments in New York State and elsewhere, there is any absence of data on the engineering properties, performance and expected service life of pavements subjected to these treatments. In addition, there is little information available on the efficacy of field installation processes (installation specifications) employed by vendors responsible for the sale and distribution of these treatments.

The goal of this investigation (conducted under task Assignment C-06-18, under NYSERDA Agreement 6764F) was to evaluate the performance of treatments in New York State installations and to develop, through an evaluation of performance, service life projections and design and installation procedures, a Best Practices Guideline. This was accomplished by undertaking two site surveys at 21 installations, over a period of two winter seasons, to examine the durability of each treatment type exposed to a number of traffic conditions. These surveys were supplemented with a review of existing design and construction specifications and procedures used to apply such treatments. The study culminated in the preparation of a Best Practices Guideline to assist NYSDOT designers, project specifiers and construction engineers during the design and installation processes.

Three types of treatments applied in New York State were examined in this study:

- 1) Textured Thermoplastic Inlays,
- 2) Textured Hot Applied Polymer Surfaces, and
- 3) Epoxy/Polymer Binder systems.

Photographs of each respective treatment type are shown in Figure 1.

Textured Thermoplastic Inlay

A Textured Thermoplastic Inlay is a hot mix asphalt (HMA) pavement that has been heated (and softened) to enable penetration by a template into the surface of the pavement. The impression induced by the template provides grooves for the placement of preformed panels of

thermoplastic material. The panels are inlaid into the grooves and heated to facilitate thermoplastic material flow and bonding with the HMA. The thermoplastic material provides the color and observed pattern.



Textured Thermoplastic Inlay, E. Central Ave. and John St., Pearl River, NY, *Thermoprint*



Hot Applied Polymer, Rt 240 and Rt 16, Buffalo, NY, *Techprint*



Epoxy/Polymer Binder, Wolf Road, Albany, NY, *TrafficDeck (Leeson Omni Grip)*

Figure 1. Textured Thermoplastic Inlay, Textured Polymer Surface and Epoxy/Polymer Binder Treatments

Textured Hot Applied Polymer Surface

A Textured Polymer Surface consists of either a hot mix asphalt (HMA) or a Portland cement concrete (PCC) pavement that has been milled and excavated to a depth necessary to permit the placement of heated, colored polymer and subsequently penetrated with a template designed to imprint a defined texture onto the surface.

Epoxy/Polymer Binder

An Epoxy/Polymer Binder pavement consists of either a hot mix asphalt (HMA) pavement or a Portland cement concrete (PCC) pavement that has been overlaid with an epoxy/polymer binder material with aggregate subsequently broadcast over the treated area. The epoxy/polymer binds with the underlying pavement and the broadcast aggregate material. An HMA treatment surface can be textured if desired. This is accomplished by heating (and softening) the HMA surface, prior to the epoxy/polymer binder application, and penetrating a template into the pavement surface. This template penetration induces a pattern to which the epoxy/polymer binder is applied.

The primary characterizing distinctions among the three treatments are as follows:

The Textured Thermoplastic Inlay treatment integrates the “asphalt pavement” directly into the treatment process by heating the pavement, and imprinting a mold into the heated pavement to provide the base for the decorative thermoplastic material. The treatment is only applicable with asphalt pavements (not Portland cement pavements).

The Textured Hot Applied Polymer Surface treatment can be used on either asphalt or Portland cement surfaces. The treatment does not integrate the “pavement” directly into the process. The

pavement is milled to provide a “form” for the placement the decorative polymer, which becomes the primary roadway surface.

The Epoxy/Polymer Binder treatment can be applied directly over an existing pavement or the pavement can be milled to provide a form for the binder material. It can be applied on asphalt or Portland cement pavements, however when used on asphalt pavements it can be integrated into the existing “asphalt pavement” structure similar to the Textured Thermoplastic Inlay, or used independently similar to a Hot Polymer Surface. It is the only one of the three processes where aggregate is broadcast over the treatment driving surface.

This report provides an overview of the activities undertaken, and the findings and conclusions associated with this effort. It represents a condensed summary of a series of Deliverables that were submitted to NYSDOT during the course of the investigation. These included Deliverables:

- Task 1: Review of Existing Literature, September 15, 2008
- Task 2: Site Evaluation Plan, January 24, 2008.
- Task 3A: Site Visit Notification, January 24, 2008.
- Task 3B: Site Visit Notification, May 14, 2009.
- Task 4A: Initial Site Survey Report, April 25, 2008.
- Task 4B: Final Site Survey Report, dated July 22, 2009.

The report, which represents the Task 5 Deliverable, Final Report, is divided into four subsequent sections: 1) Research Method, 2) Findings and Conclusions, 3) Statement of Implementation and Recommendations, and 4) Supporting Appendices. The supporting Appendices include: Appendix A: Evaluation Photo Record, Appendix B: Best Practices Guideline and Appendix C: NYSDOT Special Specifications: Architectural Pavement Treatments.

Research Method

The overall effort was conducted in a series of four primary activities that included:

1. Information Surveys,
2. Field Surveys,
3. Performance and Service Life Projections, and
4. Best Practices Guideline Preparation.

A summary of each activity is outlined below:

Information Surveys

Three information-type surveys were conducted during the investigation: 1) a Literature Review, 2) a Vendor (Marketing Agent) survey and 3) a User Agency survey.

Literature Survey

The literature survey was conducted by querying the Transportation Research Information Services (TRIS) Database and the Internet for data on architectural pavements. In addition, during the Vendor and User Agency surveys, described below, inquiries were made to Vendors as to whether known reports or published studies describing the engineering design and performance of Architectural Pavement Treatments were available.¹

Vendor Survey

A Vendor survey of a listing of 10 suppliers with New York State installations was undertaken. A listing of the products, manufacturers, and marketing agents (Vendors) are provided in Table 1. The Vendor surveys involved direct communication with product Vendors via telephone calls and survey forms. During this survey, Vendors were requested to supply product specifications and product literature and to supply locations information for sites outside of New York State where their respective treatments were applied.¹

User Agency Survey

On the basis of the information provided by the Vendors, which identified the locations of their respective installations, User Agencies (i.e., State, towns and cities where the installations were located) were contracted to obtain additional input on performance, specifications and installation procedures used for the treatments installed in their respective jurisdictions. A prepared evaluation form was used in phone surveys to User Agencies to elicit installation and performance information regarding the various products.¹

¹ Task 1: Review of Existing Literature, September 15, 2008

**Table 1
Products Evaluated**

Product Installed	Product Manufacturer	Marketing Agent (Vendor)	Treatment Type
Imprint	Prismo USA, Inc.	Integrated Paving Concepts, inc.	Hot Applied Polymer
Duratherm	Integrated Paving Concepts, Inc.	Integrated Paving Concepts, Inc.	Textured Thermoplastic Inlay
Techprint	Roadtechs Europe Ltd	Crafco, Inc	Hot Applied Polymer
Thermoprint	Pattern Paving Products	Pattern Paving Products	Textured Thermoplastic Inlay
Tyregrip	Ennis Paint Prismo	Ennis Paint Prismo	Epoxy/Polymer Binder
Crafco HFS	Crafco, Inc	Crafco, Inc	Epoxy/Polymer Binder
TrafficDeck	Leeson Polyurethanes	Greencoatings Inc	Epoxy/Polymer Binder
SprayGrip	AGY	Midland Asphalt Materials	Epoxy/Polymer Binder
Brick Print	RainLine Corporation	Traffic Calming USA, LLC	Hot Applied Polymer
FrictionPave	Pattern Paving Products	Pattern Paving Products	Epoxy/Polymer Binder

Field Surveys

Field surveys were conducted to evaluate the condition of the treated pavements during each of the two surveys using a numerical ranking system. The numerical ranking system was designed to standardize the evaluation technique. It consisted of a weighted grade of pre-selected performance (distress) factors that included a) visual contrast, b) cracking, c) adhesion, and d) abrasion. Each of the performance factors was given a score depending on the severity of the distress at a given site. The initial site survey was performed in the Fall of 2007 and the final survey was performed in the Spring of 2009. The survey schedule was designed to provide the means to examine each of the surveyed sites over two winter seasons. A total of 21 sites were included in the survey. Survey locations including treatment type are listed in Table 2.¹

¹ Task 3A: Site Visit Notification, January 24, 2008; Task 3B: Site Visit Notification, May 14, 2009.

Table 2
Field Survey Sites

Survey Site	Architectural Treatment
<ul style="list-style-type: none"> • Lake George - Route 9 and Lake Avenue 	<ul style="list-style-type: none"> • FrictionPave (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Saratoga Springs - Union Avenue Crosswalk at the Racetrack 	<ul style="list-style-type: none"> • Duratherm (Thermoplastic)
<ul style="list-style-type: none"> • Round Lake - Exit 12, Route I-87 	<ul style="list-style-type: none"> • Roundabout Aprons: Imprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Round Lake - Exit 12 off Route I-87 	<ul style="list-style-type: none"> • Splitters: Tyregrip (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Clifton Park – Old Route 146 and Cemetery Road: 	<ul style="list-style-type: none"> • SprayGrip (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Cohoes – Route 787 between. Route 32 and Ontario Rd 	<ul style="list-style-type: none"> • Tyregrip (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Troy – Fourth St. & intersection of Grand Ave 	<ul style="list-style-type: none"> • FrictionPave (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Albany – Pearl Street bet. Beaver and Morton Avenues: 	<ul style="list-style-type: none"> • Imprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Albany – Route 50 bus stop at Wolf Rd 	<ul style="list-style-type: none"> • TrafficDeck (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Niskayuna – Town Hall Entrance 	<ul style="list-style-type: none"> • Duratherm-(Thermoplastic)
<ul style="list-style-type: none"> • Schenectady – Route 7 Crosswalks at Watt St 	<ul style="list-style-type: none"> • Imprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Schenectady - Union Avenue and Seward 	<ul style="list-style-type: none"> • Duratherm (thermoplastic)
<ul style="list-style-type: none"> • Altamont – School Rd & Guilderland HS 	<ul style="list-style-type: none"> • FrictionPave (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Cheektowaga Transit Road and French Road 	<ul style="list-style-type: none"> • CrafcO HFS (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Buffalo Route 240 and Route 16) 	<ul style="list-style-type: none"> • Techprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Binghamton, NY – Court Street and Century Drive 	<ul style="list-style-type: none"> • Techprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Hoosick Falls, NY –Route 22 various locations 	<ul style="list-style-type: none"> • Imprint (Hot Applied Polymer)
<ul style="list-style-type: none"> • Pearl River, NY – E. Central Ave. at John St.Crosswalk 	<ul style="list-style-type: none"> • Thermoprint (Thermoplastic)
<ul style="list-style-type: none"> • Rochester, NY – No. Clinton Ave. and Oakman Binder) 	<ul style="list-style-type: none"> • CrafcO HFS (Epoxy/Polymer Binder)
<ul style="list-style-type: none"> • Albany, NY – Central and Fredrick 	<ul style="list-style-type: none"> • Brick Print (Hot Applied Polymer)

During the initial and final surveys, photographs were taken of each site. The photos are attached as Appendix A.

Performance and Service Life Projections

Treatment performance and service life projections were undertaken by canvassing other User Agencies during the Informational Survey activity, and the development of a simplified linear regression model using the

- 1) Date of pavement treatment (installation date),
 - 2) Date of the first 2007 field survey and
 - 3) Date of the second 2009 field survey, and
 - 4) Ranked scores for each pavement during each respective survey
- to provide projections of the expected service life of each treatment.¹

Best Practices Guideline

The Best Practices Guideline, which is presented in its entirety in Appendix B, was developed from NYSDOT specifications, vendor specifications, vendor practices as described in vendor literature, and evaluation survey comparison data. This Best Practices Guideline provides a comprehensive description of each of the referenced treatments and respectively includes information on expected performance (treatment life), installed costs, materials and equipment used in the process, and construction and inspection procedures that are typically employed when specifying the use of such treatments. It is organized in the following format.

1. Performance Record and Costs
2. Materials and Equipment
3. Construction Procedures
 - Pavement Cleaning
 - Pavement Treatment
 - Special Practices
 - Product Installation
 - Treatment Curing
4. Inspection Procedures
 - Candidate Pavements
 - Pre-Construction Testing
 - Pavement Preparation
 - Material handling and Storage
 - Construction Control
 - Temperature Control
 - Recording Keeping
5. Relevant Material Specifications.

¹ Task 4A: Initial Site Survey Report, April 25, 2008; Task 4B: Final Site Survey Report, dated July 22, 2009.

Findings and Conclusions

Information Survey Findings

- There is very little published data in the literature pertaining to Architectural Pavement Treatments.
- No specific engineering performance data were available.
- Most of the literature is vendor-related (specifications, sales) information.
- Architectural Pavement Treatment Vendors represent specific treatment products or groups of products.
- Vendors supplying Architectural Pavement Treatment products for the New York Market are served by a number of Contractors.
- Most Vendors have contractor certification programs to insure that contractors have the skills required to properly install the product.
- Only one Vendor, SprayGrip, marketed a product, and performed the construction installation for that product.
- The Contractors make use of construction specifications that are dictated in great part by the Vendors.
- The specific formulations of Architectural Pavement Treatments are often changed.
- Product lines are often transferred (sold) from one Vendor to another.
- A listing of Agencies contacted and the Products reported by each agency is presented in Table 3.
- User Agencies (State or local governments that have used architectural pavement treatments in the past) have little historical data on the performance or expected service life of the treated pavements.
- User Agencies did not report any significant objections to the use of Architectural Pavement Treatments.
- All User Agencies rely heavily on specifications supplied by Vendors for the installation of Architectural pavements.
- Florida DOT has specifications that require a three-year trial and approval period for any new product introduced into the market place; and before the product is approved for widespread use.

Table 3. User Agency Survey Summary

Architectural Pavement Treatment	User Agency	Contact Person	Phone Number	Response
Imprint	City of Hartford, CT	Keith Rapoza	860-522-4888x6585	Responded
	City of New Canaan, CT	Tiger Mann	203-594-3056	Responded
	NJDOT- Route 29	Robert Sauber	609-530-4230	Responded
	Manchester, CT	Jeff LaMalva	860-647-3158	Responded
	Middlebury, VT – Rt 7	Dan Werner	802-388-4045	Responded
Duratherm	City of Boston, MA	Dan Kehoe	617-635-2140	No response
	Springfield, MA	Chris Ignoli-Purcell Associates	860-633-8341	Responded
	City of Rutland, VT	Danny Manieri	802-353-6092	Responded
	Bennington, VT	Patrick Kinney	802-442-1037	Responded
	Willimantic, CT	Joe Gardner	860-465-3043	Responded
Techprint	City of Rome, NY	Matt Keller	315-339-7627	Responded
	City of Ithaca, Tompkins Airport, NY	Dave Crawford	607-257-0456	No response
Techprint	NJDOT	Robert Sauber	609-530-4230	Responded
	Town of Swatara, PA	Curt Wilhern	717-564-2551	Responded
Thermoprint	Rockland County, NY	Andrew Connors	845-638-5060	No response
	Cape Elizabeth, ME	Bob Malley	207-799-4151	Responded
Tyregrip				Vendor preferred not to supply project references
Crafco HFS	NJDOT Route 29	Robert Sauber	609-530-4230	Responded
	City of Bangor, ME	Dana Wordell	207-992-4501	Responded
	Braintree, MA	John Morse	781-794-8017	Responded
	Bennington, VT	Patrick Kinney	802-442-1037	Responded
	City of Hartford, CT	Kevin Burnham	860-522-4888	Responded
TrafficDeck (Omni Grip)				No references from vendor
Friction Pave	FLDOT	Charles Holzchuher	352-955-6341	Responded
Spray Grip				No response from vendor
Safe Lane	City of Hibbing, MN	Jesse Story	218-312-9723x722	No response
	Superior, WI-US Route 53 and US Route 2		715-395-7334	No response
	Lansing, MI-US Route 127	Mr. Landry	517-483-4240	No response
	NJDOT-Rt 80 (Ramp)	Bob Sauber	609-530-4230	Responded

- Portions of Architectural Pavement Treatments that are elevated above the contiguous surface plane of the treatment are susceptible to snowplow damage.
- Snowplow damage was considered a minor problem by a select number of the User Agencies surveyed (Bennington VT - Crafco HFS, Hartford CT-Imprint, Cape Elizabeth ME- Thermoprint, Bangor ME – Crafco HFS).

- NYSDOT has a specification requirement for friction properties of Thermoplastic Inlay treatments. This requirement is a minimum British Pendulum Number of 52 to 62.

Information Survey Conclusions

- The literature provides little to support engineering, performance or service life projections.
- The Vendor specifications are instrumental in applying architectural pavements.
- The change in product formulation and product ownership can make tracking the performance of products difficult unless a database is maintained of products in use.
- Vendor data are currently the most comprehensive data available and are more useful than published literature in establishing guidelines on Architectural Pavement Treatment use.
- Snowplow damage to Architectural Pavement Treatments is localized to high points in the treatment and is not considered a significant problem by many of the User Agencies surveyed.
- Florida DOT's trial and approval period provides a controlled methodology for evaluating, monitoring and documenting new product performance.

Field Surveys and Performance Findings

- Of the 21 product sites evaluated in this part of the study, 10 exhibited no measurable deterioration (change in rating value between the initial and final surveys).
- The primary distress factor was abrasion wear, localized in the wheel paths and concentrated at locations where tire-turning frequency is high.
- Abrasive wear caused by snowplow action is concentrated at high points in the surfaces of treatments.
- Textured Hot Applied Polymer treatment applications exhibited cracking in isolated areas. Two types of cracking were observed. The more serious crack type was localized in small areas (usually less than 30 square feet) where the cracks were roughly parallel and spaced about an inch apart. The second type was observed as transverse cracks across the narrowest cross section of the treatment. These usually occurred at corners in applications where the cross section was considerably less than in other portions of the treatment.
- The Textured Thermoplastic Inlay and the Epoxy Polymer Binder treatment types did not display cracking distress, except for an occasional reflection crack through the underlying pavement.

- Distress in Thermoplastic Inlay treatments was directly related to the erosion of aggregates in the adjacent asphalt pavement; and when the erosion is such that the asphalt pavement wears down to the same level of the thermoplastic treatment, the thermoplastic treatment fails.
- Epoxy/Polymer Binder treatments that incorporated high quality aggregate materials (e.g., bauxite), which was used in applications at Rochester (Crafco HFS) and Clifton Park (SprayGrip) exhibited little abrasive wear.
- Considerable wear in the wheel path areas, does not measurably reduce the visually defining feature of the crosswalks safety zone.
- No relationship between traffic and expected treatment life could be determined from the data.
- The linear model developed to project the service life of Architectural Pavement Treatments found that such treatments can be expected to remain serviceable for at least from 4 to 7 years.

Field Surveys and Performance Conclusions

- Thermoplastic treatment surfaces, when exposed to direct tire abrasion wear faster than adjacent asphalt pavement surfaces.
- Hot Applied Polymer installations that exhibited cracking distress were likely due the result of one more of the following: 1) Failure of the treatment to adequately bond to the pavement, 2) Insufficient stress relieving joints in the treatment, 3) Improperly placed saw cuts over joints in the substrate pavement (resulting in reflective cracking), and/or 4) Embrittlement of the treatment. The cause of the cracking notwithstanding, these cracks will lead to early deterioration of the treatment.
- Even when treatments exhibited wheel path abrasion to the point where the treatment was removed in the wheel paths, the installation still functioned as a visible safety sentinel.
- Architectural Pavement Treatments can be expected to perform satisfactorily and effectively for several years, given reasonable traffic volume and the employment of proper installation procedures.
- The service life of Thermoplastic Inlay Treatments will be extended if they are installed in pavements where the adjacent pavement is in good condition and is not expected to wear excessively (e.g., asphalt pavement constructed with hard durable aggregates).
- Architectural Pavement Treatments exposed to tire abrasive forces will more effectively resist surface abrasion when hard, durable aggregate materials like bauxite, quartz or granite are utilized.

Statement of Implementation and Recommendations

NYSDOT currently supports local municipalities that plan the installation of Architectural Pavements in their jurisdictions. The general design process includes the selection of a treatment type and product to be used on a given project. The primary factors involved in the selection include the aesthetic quality of the application as judged by the local municipality, and the product cost. The NYSDOT has Special Specifications (see Appendix C) for all three treatment types that follow a general format that lists the requirements for the raw materials, requirements for Materials Bureau approval, pavement condition, equipment, coordination, method of measurement, basis of payment, surface preparation requirements, and installation practices. In the case of installation practices, however, all three specifications defer to the “manufacturer’s recommendations”. There are no special performance or reporting requirements. Payment is made when the product is successfully installed.¹

Based on the findings and conclusions of this study it is suggested that the following recommendations be implemented:

- NYSDOT should establish an approved list of Architectural Pavement Treatments, using trial and approval methods similar to Florida DOT.
- NYSDOT should develop criteria to define when an Architectural Pavement Treatments has reached the end of its service life. This may be accomplished by utilizing pavement evaluation criteria similar to that developed during this study.
- NYSDOT should continue to track existing Architectural Pavement Treatments to obtain better long-term data that could be used to more accurately project the service lives of the individual treatments types.
- NYSDOT should incorporate specification language to insure that high points on pavement surfaces to be treated should be removed to avoid snowplow damage.
- NYSDOT should ensure that the Vendors of cracking in Hot Applied Polymer systems investigate the observed cracking problems so that the long term performance of such treatments are not compromised by such cracking.
- NYSDOT should consider a requirement in its Special Specifications on Architectural Pavement Treatments that all treatments use aggregates that exhibit a minimum British Pendulum Number of 52.

¹ NYSDOT Specifications:

- Textured Asphalt Pavement with Thermoplastic Inlay, Section 601.9402—02[1]
- Surface Treatment for Pavements Type 2, Traffic Grade, Section 601.20---01[1] [1]
- Integrally Colored Hot Applied Textured Polymer Wearing Surface, Section 601.03---09[1].

²Task 4A:Initial Site Survey Report, April 25, 2008.

Reference Documents

Manual of Uniform Traffic Control Devices (MUTCD)

“National Standard for Traffic Control Devices; Manual on Uniform Traffic Control Devices for Streets and Highways”, FHWA, 23CFR part 655, 2000.

New York State Department of Transportation, Standard Specifications for Construction and Materials, 2006

The following NYSDOT Special Specifications:

Textured Asphalt Pavement with Thermoplastic Inlay, Section 601.9402—02[1]

Surface Treatment for Pavements Type 2, Traffic Grade, Section 601.20----01[1] [1]

Integrally Colored Hot Applied Textured Polymer Wearing Surface, Section 601.03----09[1]

ASTM E-303 Standard Test to determine British Pendulum Number

ASTM D-36 Standard Test to Determine the Softening Point of Bitumastic Materials

ASTM D-3349 Standard Test Method for Measuring Adhesion by Tape Test

ASTM C-881 Standard Specification for two Component Epoxy Binder

AASHTO M249, Standard Specification for White and Yellow Reflective Thermoplastic Striping Material

Appendix A: Evaluation Photo Record

Project: Lake George, New York – Rt. 9 and Lake Avenue
Year Installed: 2005 Product: FrictionPave

2007 photos	2009 photos
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Project: Saratoga, New York – Union Avenue, Crosswalk at Racetrack Entrance
Year Installed: 2002
Product: Duratherm

2007 photos	2009 photos
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Project: Round Lake, New York – I-87, Exit 12 Roundabout Splitter Islands
Year Installed: 2006 Product: Tyregrip

2007 photos



2009 photos



Project: Cohoes, New York – I-787 Shoulders between Rt. 32 and Ontario Street
Year Installed: 2003 Product: Tyregrip

2007 photos



2009 photos



Project: Troy, New York – 4th Street and Grand Avenue

Year Installed: 2004

Product: FrictionPave

2007 photos



2009 photos



Project: Albany, New York - Pearl Street between Beaver and Morton Avenues
Year Installed: 2006 Product: Imprint

2007 photos	2009 photos
-------------	-------------



Project: Albany, New York – Wolf Road and Adjacent Sidewalk
Year Installed: 2004 Product: TrafficDeck (Leeson Omni Grip)

2007 photos	2009 photos
-------------	-------------



Project: Niskayuna, New York – Town Hall Entrance
Year Installed: 2005 Product: Duratherm

2007 photos	2009 photos
-------------	-------------



Project: Schenectady, New York – Route 7 at Watt Street
Year installed: 2007 Product: Imprint

2007 photos

2009 photos



Project: Schenectady, New York – Union Avenue and Seward
Year Installed: 2002
Product: Duratherm

2007 photos

2009 photos



Project: Altamont, New York – School Road and Guilderland High School Entrance
Year Installed: 2005 Product: FrictionPave

2007 photos	2009 photos
-------------	-------------



Project: Cheektowaga, New York – Transit Road and French Road
Year Installed: 2005 Product: Crafcro HFS

2007 photos

2009 photos



Project: Buffalo, New York – Rt. 240 and Rt. 16
Year Installed: 2005 Product: Techprint

2007 photos

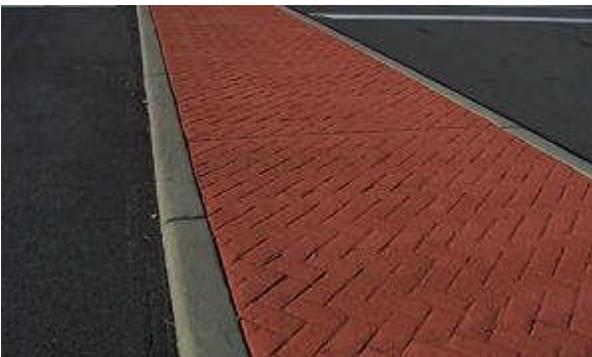
2009 photos



Project: Binghamton, New York – Court Street and Century Drive
Year Installed: 2005 Product: Techprint

2007 photos

2009 photos



Project: Pearl River, New York – East Central Avenue and John Street
Year Installed: 2005

Product: Thermoprint

2007 photos	2009 photos
-------------	-------------



Project: Rochester, New York – North Clinton Avenue and Oakman Street
Year installed: 2007

Product: Crafcro HFS

2007 photos	2009 photos
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Project: Albany, New York - Central Avenue Various Locations
Year Installed: 2008 Product: Brick Print

2007 photos

2009 photos



Appendix B: Best Practices Guideline

**BEST PRACTICE GUIDELINE
FOR
ARCHITECTURAL PAVEMENT TREATMENTS**

**PREPARED FOR
THE NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
UNDER
AGREEMENT 6764F,
NYSDOT TASK ASSIGNMENT: C-06-18**

**PREPARED BY
CHESNER ENGINEERING, P.C.
LONG BEACH, NEW YORK**

January 28, 2010

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Introduction

Architectural pavement treatments are applied by planners and architects, to crosswalks and/or roundabouts, and other roadway areas where special pavement properties are required, to enhance the appearance of a local downtown environment. When used in conjunction with similar treatments on sidewalks, the entire appearance of a downtown area may be changed for the better. Architectural pavement treatments used in roundabouts and other applications add significantly to the visibility, delineation and traffic direction of the installation. Although provisions of the Manual of Uniform Traffic Control Devices (MUTCD) are designed to address safety markings that must be employed at crosswalks, architectural pavements can provide an additional element of safety by introducing a vivid, secondary visual message to both the pedestrian and motorist that a crosswalk is present.

There are three types of architectural pavement treatment currently used in New York State in both crosswalk and roundabout applications. These include

1. Textured Thermoplastic Inlays,¹
2. Textured Polymer Surfaces,² and
3. Epoxy/Polymer Binders.³

This Best Practice Guideline provides a description of each of the referenced treatments and respectively includes information on expected performance (treatment life), installed costs, materials and equipment used in the process, and construction and inspection procedures that are typically employed when specifying the use of such treatments.

The user of this Best Practice Guideline should be aware that structural deficiencies present in the existing pavement will manifest as defects in the architectural pavement treatments placed over such pavements. Similarly, the user should be aware that if such treatment surfaces are elevated above grade there may be additional stresses acting on the treatment as the result of recurring snow plow action.

1. Textured Thermoplastic Inlay

A Textured Thermoplastic Inlay is a hot mix asphalt (HMA) pavement that has been heated (and softened) to enable penetration by a template into the surface of the pavement. The impression induced by the template provides grooves for the placement of preformed panels of thermoplastic material. The panels are inlaid into the grooves and heated to facilitate thermoplastic material flow and bonding with the HMA. The thermoplastic material provides the

¹ “Textured Thermoplastic Inlay” is a shorthand term used in this Guideline to describe “Textured Asphalt Paving with thermoplastic Inlay”. See NYSDOT Special Specifications, Item 601. 9402 02.

² “Textured Polymer Surface” is a shorthand term used in this Guideline to describe “Integrally Colored Hot Applied Textured Polymer Wearing Course- Coarse Aggregate Type 2F Conditions,” See NYSDOT Special Specifications Item 601.03---09.

³ “Epoxy/Polymer Binder” is a shorthand term used in this Guideline to describe “Surface Treatment for Pavements Type@ Traffic Grade”. See NYSDOT Special Specifications Item 601.20 01M

color and observed pattern. A photograph depicting a thermoplastic inlay installation is shown in Figure 1.



**Figure 1. Textured Thermoplastic Inlay Installation
E. Central Ave. and John St., Pearl River, NY, Thermoprint**

Table 1.1 summarizes some of the key engineering and design features for Thermoplastic Inlays.

Table 1.1 Thermoplastic Inlay: Engineering, Design and Construction Features	
Application Process	Comment
Performance Record and Costs	Expected life at least 4 years. 2009 Cost Projections: \$11-18 per square foot.
Materials and Equipment	Thermoplastic Panels, Infrared Heater, Vibratory Compactor, Inlay Template, Optical Thermometer and Cleaning Materials and Equipment.
Construction Procedures	Pavement Cleaning, Pavement Heating, Template Impression, Thermoplastic Placement, Thermoplastic Heating and Cooling.
Inspection Procedures	Candidate Pavements, Pre-Construction Testing, Pavement Preparation, Thermoplastic Material Handling and Storage, Temperature Control, and Record Keeping.
Relevant Material Specifications	AASHTO M249 “Standard Specification for White and Yellow Reflective Thermoplastic Striping Material”, ASTM D3349 “Standard Test Method for Measuring Adhesion by Tape Test”. ASTM D36 “Standard Test Method for Softening Point of Bitumen”.
Installation Rate	Approximately 1000 sq. ft., per day ¹
Vendors	Duratherm and Thermoprint.

¹ Production capacity depends primarily on the type of asphalt pavement, ambient temperature, traffic control, coordination, and crew size.

1.1 Performance Record And Costs

Since most thermoplastic inlay installations in New York State are recent installations (e.g., installed within the last 7 years), it is difficult to project the expected life of such treatments. The expected life will depend on the quality of the construction procedure and the traffic density to which the treatment will be exposed. Other State and local government agencies have reported that selected installations have been performing satisfactorily up to four years after installation. Based on these reports and field surveys of New York State installations, it is projected that properly installed thermoplastic inlays should last a minimum of four years.¹ The depth of the thermoplastic inlay and how well it bonds to the pavement during installation are the key performance parameters. Table 1.2 summarizes the field survey data and other agency interview data that were used to project the expected service life of the subject treatment.

Table 1.2 Expected Service Life Estimates ¹		
Product	NYS Field Surveys ^{1,2}	Other Agency Interviews ^{1,5}
Duratherm	Up to 7 years	4 years ³
Thermoprint	4 years	1 year ⁴
1. All of the numbers reported here are of installations that are in continuing service. Longer periods of effective service may be anticipated. 2. NYSDOT Task 4B Deliverable, Agreement No.6764F, C-06-18, dated August 24, 2009 3. Telephone surveys with transportation officials from Boston MA, Springfield MA, Rutland VT, Bennington VT, Willimantic CT, and Rockland County NY. 4. Telephone surveys with transportation officials from Cape Elizabeth ME. 5. NYSDOT Task 1 Deliverable, Agreement No. 6764F, C-06-18, dated September 15, 2008		

The cost for treating a pavement with thermoplastic materials will vary depending on the size of the project, project location, and site geometry. Installed costs (2009) can be expected to range from \$11 to \$18 per square foot.²

1.2 Materials and Equipment

The thermoplastic material is a polymeric resin material that includes pigments, fibers, and glass beads. The glass beads are uniformly distributed throughout the material. Usually a percentage of glass beads is specified and this may be 25 or 30 percent by weight. In some cases, where exceptional retro-reflectivity is required, additional glass beads are broadcast over the surface of the hot thermoplastic before it sets.

Equipment required to undertake the installation include infrared heating equipment, a vibratory compactor, an optical thermometer, rigid steel, plastic or aluminum template, and pavement cleaning equipment and materials.

¹ NYSDOT Task Deliverable 4B, Agreement No. 6764F, C-06-18. Dated August 24, 2009.

² Cost data was supplied by representatives of two vendors (Duratherm and Thermoprint).

1.3 Construction Procedures

Treating a pavement using a textured thermoplastic inlay involves a series of field operations that include pavement cleaning, pavement heating, template indentation, and thermoplastic placement and compaction.

Pavement Cleaning

The existing asphalt pavement surface is initially cleaned of all loose and adhering debris, salt from previous deicing operations, and stains of grease or oil, present on the surface of the pavement. This is typically accomplished by sweeping the area with a stiff bristle broom or a power broom, and if needed (persistent debris and stains continue to adhere to the surface), the use of a power washer.

Stains of grease or oil present a particular problem. The thermoplastic material will not adhere to areas stained with petroleum products. Again, the power washer may be effective in cleaning these stains and a non-solvent based degreaser can be employed. The non-solvent based degreaser is typically placed on the stain area and allowed to sit for a period of at least 15 minutes before it is removed by power washing. Solvents or solvent-based detergents cannot be used on HMA surfaces to remove petroleum stains since they will dissolve the asphalt binder.

Pavement Heating

After the pavement is cleaned it is treated with a reciprocating infrared radiant heater to raise the surface temperature to at least 210 degrees F. The reciprocating infrared radiant heating device consists of a bank of heating elements mounted on a wheeled, steel frame. It is powered by an engine and steered by an operator who walks in front of the device. It is equipped with an infrared optical thermal detector that continually monitors the temperature of the asphalt pavement and the textured thermoplastic inlay, when it is subsequently applied (see below). Special care is taken to avoid raising the temperature too high because at temperatures over 325 degrees F asphalt binder properties can be irreversibly altered.

Template Impression

Once the temperature of the surface has reached 210 degrees F, a rigid, steel, aluminum or plastic template is placed in the designated location. The dimensions of the template are usually 3 feet by 5 feet, but may vary widely depending on the needs of a given project. A vibrating compactor or other approved tool is subsequently used to impress the template into the surface of the pavement. Special care is taken to insure that the proper depth of impression is achieved. The depth of the inlay must be greater than the thickness of the thermoplastic panel. Generally, grooves are one half inch deep. The thermoplastic panels are three-eighths of an inch thick. It is important to install the thermoplastic panel below the surface of the pavement. If the thermoplastic panel extends above of the surface, it will quickly abrade and an early failure of the installation can be expected. When properly applied the thermoplastic material is at least one-eighth of an inch below the top surface of the pavement.

Thermoplastic Placement

Thermoplastic inlays are delivered to a jobsite as panels in an installation-ready condition. At the time of installation, the panels are individually placed in the inlaid grooves. Care must be taken to insure that the panel is fitted to the bottom of the groove and centered so that the thermoplastic panel is seated as deeply as possible within the groove. If panel material extends above the level of the top of the asphalt pavement, the groove is not deep enough or the panel is not properly placed, premature failure can occur. If the groove does not have sufficient depth, the indentation process using the rigid template should be redone. Adjacent thermoplastic panels are placed so the edges abut and there are no gaps between panels.

Thermoplastic Heating and Cooling

Once the panel is properly fitted, the infrared heater is used to heat the thermoplastic material to 280 plus or minus 15 degrees F. This will soften the thermoplastic allowing it to flow into the grooves and to thoroughly bond with the asphalt pavement. A successful operation will eliminate any visible joint between adjacent panels. When the thermoplastic material cools to below 140 degrees F, the roadway may be reopened to traffic.

1.4 Inspection Procedures

Candidate Pavements

It is important that the candidate pavement be in sound condition. Any distress such as rutting, cracks, raveling or other anomalies should be corrected prior to the treatment.

Pre-Construction Testing

Two types of preconstruction quality control tests are available. The first is designed to address architectural issues and the second engineering Issues.

Architectural Issues:

It is common practice for Contractors to prepare pre-installation samples of the specified treatment. These samples, which are prepared on a rigid frame with typical dimensions of 60 cm by 60 cm, are used as a control, to establish the expected pattern and color that will be produced in the field. The samples, which consist of a layer of hot mix asphalt (at least 37.5 cm thick) with the imbedded thermoplastic inlay, are prepared in the exact manner that the Contractor intends to perform the project (i.e., the construction process of heating, inlaying, installing and heating the thermoplastic panel). Preparation of such samples provides a means for the Architect or Engineer to approve the treatment prior to construction and to compare the actual field installation to the agreed-upon control sample.

Engineering Issues:

No engineering tests are currently conducted prior to construction to assess the degree to which a thermoplastic inlay application might affect the quality of the finished pavement. British Pendulum Number (BPN) testing (ASTM E-303) is commonly used to evaluate the friction

properties of other architectural pavement treatments. However, since a thermoplastic inlay is installed below the level of the pavement, and would not be in contact with vehicular tires, and since the relative area of pavement affected by the inlay is less than 10 percent of the pavement, the value of skid testing using ASTM E-303 test procedures is questionable. The skid resistance of a thermoplastic inlay treated pavement can be expected to be a function of the skid resistance of the existing pavement.

Pavement Preparation

Deposits of fine-grained material or petroleum residues in the impressed grooves will prevent proper bonding of the thermoplastic with the surface of asphalt pavements. Adequate cleaning techniques should be closely monitored to ensure a clean surface prior to thermoplastic inlay application. The depth of the grooves installed in the pavement should also be checked to insure that the proper depth has been achieved.

Thermoplastic Material Handling and Storage

It is important that the specified thermoplastic material be delivered in sealed containers that are marked with the manufacturer's name, product name, date of manufacture, and color. The material, once delivered to the project site should be stored out of direct sunlight and protected from the elements, and in an environment of 60 degrees F plus or minus 6 degrees F or as required by the manufacturer. The raw material will typically have a shelf life of at least two years.

Construction Control

During the installation of the thermoplastic panels in the grooves, it is important to insure that the panels are fully impressed into the grooves. Additionally, adjacent panels are situated in such a way as to insure that the heated panels will melt and bond to each other. Temperature control during the thermoplastic melting operation is critical to the quality of the placement. A small pry or sharp edged tool may be used to probe the interface of the two materials. If bonding does not occur, the operation should be stopped until the reason for the lack of bonding is determined and corrected.

Temperature Control

An optical thermometer should be used to insure that the appropriate temperature range is achieved. The temperature of the asphalt pavement should be maintained below 295 degrees F and care must be taken to prevent the temperature from exceeding 325 degrees F. Once the material cools it should be immediately inspected to determine if the bonding of the thermoplastic material to the asphalt material is complete. If the bonding is incomplete reheating of the thermoplastic may correct the problem. If it does not correct the problem a study should be made to determine why bonding is not occurring and then appropriate action taken.

Record Keeping

The Contractor should keep accurate records of the use of all thermoplastic materials, including the date of manufacture of the material and the lot numbers. This information should be compared to the date and the exact location that the material is used on the project. At the completion of the project, these records or a copy of these records should be given to the Engineer. The Contractor should also maintain an accurate log of the activities that constitute the work that is required, including the date and acceptability of the surface preparation, ambient temperatures (as high and low values for the days when work takes place) and relative humidity for each work day. This log should be made available to the Engineer on request and a copy should be delivered to the Engineer at the completion of the project. The Contractor should also maintain a photo record of the progress of the work to include photos of the work area surface, prior to the start of surface preparation, any cracked or distressed areas that need repair, the imprinted surface prior to the placement of the thermoplastic panels, and the thermoplastic material in place after heat bonding.

1.5 Relevant Material Specifications

The thermoplastic material should be manufactured to the requirements of AASHTO M249 “Standard Specification for White and Yellow Reflective Thermoplastic Striping Material”. The material should have two significant properties. First, when it has cooled, it must bond with the asphalt material and aggregates in the pavement. This property is measured by performing ASTM D3349 “Standard Test Method for Measuring Adhesion by Tape Test”. Generally, this test should show at least 50 % of the surface area of the bond surface of the treatment having particles of asphalt adhering. Secondly, it is important the thermoplastic material should resist softening by the sun. This is required to avoid deformation or pickup of the thermoplastic material by traffic. This property is determined by performing ASTM D36 “Standard Test Method for Softening Point of Bitumen”. This test is also known as the Ball and Ring Test. The material tested must show a softening point between 180 and 215 degrees F.

2. Textured Polymer Surface

A Textured Polymer Surface consists of either a hot mix asphalt (HMA) or a Portland cement concrete (PCC) pavement that has been milled and excavated to a depth necessary to permit the placement of heated, colored polymer, which can subsequently be treated with a template designed to imprint a defined texture onto to the surface. A photograph depicting a textured polymer installation is shown in Figure 2.



**Figure 2. Textured Hot Applied Polymer Surface Installation
Rt. 240 and Rt. 16 Buffalo, Techprint**

Table 2.1 summarizes some of the key engineering and design features for Textured Polymer Surfaces.

Table 2.1 Textured Polymer Surface: Engineering, Design and Construction Features	
Application Process	Comment
Performance Record and Costs	Expected life greater than 4 years. 2009 Cost Projections: \$14.00 – 23.00 per square foot.
Materials and Equipment	Thermoplastic Resins, Pigment, Aggregates, Portable Milling Machine, Kettle Reactor, Heated Spreading Screed, Texturing Template, Hand held Optical Thermometer
Construction Procedures	Milling, Cleaning, Placing, Spreading, Texturing
Quality Assurance and Control	Candidate Pavements, Pre-Construction Testing, Pavement Preparation, Thermoplastic Material Handling and Storage, Temperature Control, and Record Keeping.
Relevant Material Specifications	ASTM E-303 Standard Test to determine British Pendulum Number
Installation Rate	Approximately 300 sq. ft., per day ¹
Vendors	Imprint, Brick Print, Techprint

¹ Production capacity depends primarily on the type of asphalt pavement, ambient temperature, traffic control, coordination, and crew size.

2.1 Performance Record And Costs

Since most textured polymer surface treatments in New York State are recent installations (e.g., installed within the last 4 years), it is difficult to project the expected life of such treatments. The expected life will depend on the quality of the construction procedure and the traffic density to which the treatment will be exposed. The site evaluations indicated that all three of the products in the textured polymer surface treatment category exhibited some form of cracking (see Table in Task4B⁶). This cracking was in various locations but some were in wheel paths. Other State and local government agencies have reported that selected installations have been performing satisfactorily up to two years after installation. Based on these reports and field surveys of New York State installations, it is projected that textured polymer surfaces should last a minimum of four years.¹ Table 2.2 summarizes the field survey data and other agency interview data that were used to project the expected service life of the subject treatment.

Table 2.2 Expected Service Life Estimates¹		
Product	NYS Field Surveys^{1,2}	Other Agency Interviews^{1,5}
Imprint	Up to 4 years	2years ³
Brick Print	6 months	No data available
Techprint	Up to 4 years	1 year ⁴
1. All of the numbers reported here are of installations that are in continuing service. Longer periods of effective service may be anticipated. 2. NYSDOT Task 4B Deliverable, Agreement No.C-06-18, dated August 24, 2009. 3. Telephone surveys with transportation officials from Hartford CT, New Canaan CT, NJDOT, Manchester CT, and Middlebury VT. 4. Telephone surveys with transportation officials from Rome NY, the New Jersey Department of Transportation (NJDOT) and Ithaca NY. 5. NYSDOT Task 1 Deliverable, Agreement No. 6764F, C-06-18, dated September 15, 2008.		

The cost for treating a pavement with a textured polymer surface will vary depending on the size of the project, project location, and site geometry. Installed costs (2009) can be expected to range from \$14.00 to \$23.00 per square foot.²

2.2 Materials and Equipment

The textured polymer material is a polymeric resin material that includes pigments, reinforcing fibers and aggregate material. As a final application to the treatment surface, silica sand is broadcast over the still hot treatment at a rate of 1 kg per square meter to enhance the friction properties of the treatment. This silica sand application occurs before the surface is textured. Equipment required to undertake the installation include heating kettles, hot polymer transportation devices, heated spreading iron devices, texturing templates, sand spreading tools and a vacuum system to remove excess sand after cooling of the textured polymer.

¹ NYSDOT Task Deliverable 4B, Agreement No. 6764F, C-06-18. Dated August 24, 2009.

² Cost data was supplied by representatives of three vendors (Imprint, Brick Print, Techprint).

2.3 Construction Procedures

Treating a pavement using a textured polymer surface application involves a series of field operations that include milling and cleaning, polymer heating, polymer placement, silica sand addition and polymer texturing.

Milling and Cleaning

The entire area to be treated is milled, using a milling machine, to excavate the surface of the pavement to the uniform depth and the lateral limits required by the contract. A boundary line “key” is sometimes installed along the ends of the treated pavement to reduce potential pavement damage from snowplow impacts. A boundary line “key” provides for a uniform thickness over the surface with a gradual tapered elevation change so that the treated pavement ties into the edge of the adjacent untreated pavement.

The treated area is subsequently cleaned to insure there is no residual debris left after the milling and to remove any stains or grease or petroleum residue remaining on the surface. Granular residue may be removed by sweeping or the use of compressed air. If grease or petroleum stains are present, high-pressure water washing techniques may be employed to remove them. If grease or petroleum stains persist, a non-solvent based degreaser can be placed on the stain area and allowed to sit for a period of at least 15 minutes and subsequently removed by power washing. Solvents or solvent-based detergents cannot be used on HMA surfaces to remove petroleum stains since they will dissolve the asphalt binder.

Polymer Heating

After the area is prepared, the raw textured polymer material is heated to the temperature specified by the polymer manufacturer in a reactor; a heating Kettle usually supplied by the manufacturer that heats the hot polymer material to the required temperature.

Polymer Placement

The surface of the asphalt pavement is also heated to a temperature of between 190 degrees and 215 degrees F. When the prescribed temperature is reached the textured polymer material is moved to the work area in a heated transporter, placed on the work surface and spread to a thickness of 18mm to 25mm.

Silica Sand Addition

Immediately after placement and while the textured polymer material is still hot, silica sand is applied at the rate of 1 kg silica sand per square meter of treatment surface.

Polymer Texturing

Before the material cools it is imprinted with a steel template to impart a texture to the surface that suggests a brick finish or other architectural finish. The textured grooves in the treatment should be 6 mm + or – 2 mm deep. After cooling, the excess or free silica sand material is removed from the surface by sweeping or vacuum cleaning. The pavement may be opened to traffic when the temperature has reached ambient temperatures.

2.4 Inspection Procedures

Candidate Pavements

It is important that the candidate pavement be in sound condition. Any distress areas such as rutting, cracks, raveling or other anomalies should be corrected prior to the application of the treatment.

Pre-Construction Testing

Two types of preconstruction quality control tests are available. The first is designed to address architectural issues and the second engineering Issues.

Architectural Issues:

It is common practice for Contractors to prepare pre-installation samples of the specified treatment. These samples, which are prepared on a rigid frame with typical dimensions of 60 cm by 60 cm, are used as a control, to establish the expected pattern and color that will be produced in the field. The samples, which consist of a layer of either HMA or PCC (at least 37.5 cm thick) with the hot polymer bonded to it, are prepared in the exact manner that the Contractor intends to perform the project (i.e., the construction process of heating, inlaying, installing and heating the thermoplastic panel). Preparation of such samples provides a means for the Architect or Engineer to approve the treatment prior to construction and to compare the actual field installation to the agreed-upon control sample during construction.

Engineering Issues:

British Pendulum Number (BPN) testing (ASTM E-303) is commonly used to evaluate the friction properties of architectural pavement treatments. This can be achieved prior to construction by having the Contractor supply the Engineer with test data from an independent testing laboratory that indicates the material supplied for the project when tested in accordance with ASTM E-303 exhibits minimum skid resistance values of 52 British Pendulum Number (BPN).

Pavement Preparation

After the milling operation (full depth mill or a keyway approach), the application area should be inspected for the presence of loose granular materials and for the presence of grease or oil stains on the surface of the milled pavement. Loose debris should be removed and stains should be

washed with a pressure washer or non-solvent detergents. In any event, the surface should be free of any debris or stains before the textured polymer is applied.

Textured Polymer Material Handling and Storage

It is important that the specified textured polymer material be delivered in sealed containers that are marked with the manufacturer's name, product name, date of manufacture, and color. The material, once delivered to the project site should be stored out of direct sunlight and protected from the elements, and in an environment of 70 degrees F plus or minus 6 degrees F or as required by the manufacturer. The raw material will typically have a shelf life of at least two years.

Construction Control

During the placement of the textured polymer material, it is important to monitor the temperature of the textured polymer material and the pavement, the textured polymer placement thickness, the amount of silica sand applied, the treatment texture, and the cleaning of the excess silica sand. As soon as the textured polymer cools the inspector should ascertain that the material has adequately bonded to the substrate by using a small levering tool to attempt to pry up the material. Any loose materials must be removed and replaced.

Temperature Control

An optical thermometer is used during the inspection process to insure that the appropriate temperature range for the heating of the textured polymer is achieved. The temperature of the asphalt pavement substrate is maintained at a temperature of at least 190 degrees, but less than 225 degrees F. Care must be taken to prevent the temperature of the asphalt pavement from exceeding 325 degrees F.

Record Keeping

The Contractor should keep accurate records of the use of all textured polymer materials, including the date of manufacture of the material and the lot numbers. This is coupled to the date and the exact areas where each particular lot of material was used. At the completion of the project, these records or a copy of these records should be given to the Engineer. The Contractor should also maintain an accurate log of the activities that constitute the work that is required, including the date and acceptability of the surface preparation, ambient temperatures (as high and low values for the days when work takes place), and relative humidity for each work day. This log should be made available to the Engineer on request and a copy should be delivered to the Engineer at the completion of the project. The Contractor should also maintain a photo record of the progress of the work, to include photos of the work area surface, prior to the start of surface preparation, cracked or distressed areas that need repair, the imprinted surface prior to the placement of the textured polymer material, and the textured polymer material in place after heat setting.

2.5 Relevant Material Specifications

The textured polymer should be a polymer resin product manufactured in such a way that it acts as a plastic material in the temperature range of from 200 to 300 degrees F. At ambient temperatures, it should be hard and durable and resist the effects of the abrasion of vehicular tires. The material should have two significant properties. First, when it has cooled, it must bond with the asphalt material and aggregates in the pavement. This property can be measured by using a small prybar to attempt to lever the treatment off the pavement. Only slight pressure is required since the product if not bonded, will readily separate from the pavement. Additionally, the hot polymer treatment in its hardened state should have a minimum British Pendulum Number of 52, when tested in accordance with ASTM E-303 “Standard Test to Determine British Pendulum Number”.

3. EPOXY/POLYMER BINDER

An Epoxy/Polymer Binder consists of a treatment placed on either a hot mix asphalt (HMA) pavement or a Portland cement concrete (PCC) pavement that is an epoxy/polymer binder material with aggregate subsequently broadcast over the treated area. The epoxy/polymer binds with the underlying pavement and the broadcast aggregate material. The treatment surface can be textured, if desired, by heating (and softening) the HMA surface, and penetrating it with a template prior to the epoxy/polymer binder application. The penetration induces a pattern to which the epoxy/polymer binder is applied. Photographs depicting textured and un-textured epoxy/polymer binder installations are shown in Figure 3 and 4, respectively.



Figure 3. Typical Epoxy/Polymer Binder with Texturing installation, location unknown, Pattern Print (This product was not evaluated in this study.)



Figure 4. Typical Epoxy/Polymer Binder Installation, North Clinton Ave. and Oakman St., Rochester, NY, Crosswalk without texturing, CrafcOHFS

Table 3.1 summarizes some of the key engineering and design features for Epoxy/Polymer Binder Surfaces.

Table 3.1 Epoxy/Polymer Binder: Engineering, Design and Construction Features	
Application Process	Comment
Performance Record and Costs	Expected life at least 6 years. 2009 Cost Projections: \$2 to 11 per square foot.
Materials and Equipment	Epoxy/Polymer Binder, Infrared Heater, Vibratory Compactor, Texturing Template, Optical Thermometer and Cleaning Materials and Equipment.
Construction Procedures	Pavement Cleaning, Pavement Heating, Template Impression, Epoxy/Polymer Mixing, Aggregate Application, Cleaning Materials and Equipment.
Quality Assurance and Control	Candidate Pavements, Pre-Construction Testing, Pavement Preparation, Epoxy/Polymer Binder Packaging and Storage, Epoxy/Polymer Mixing, Temperature Control, and Record Keeping.
Relevant Material Specifications	ASTM C-881 Grade 1 “Standard Specification for two component Epoxy Binder” or equivalent. ASTM D-3349 “Standard Test Method for Measuring Adhesion by Tape Test”. ASTM E-303 “Standard Test to Determine British Pendulum Number”
Installation Rate	Approximately 5000 sq. ft., per day ¹
Vendors	CrafcOHFS, Tyregrip, TrafficDeck, FrictionPave, and Spraygrip

¹ Production capacity depends primarily on the type of asphalt pavement, ambient temperature, traffic control, coordination, and crew size.

3.1 Performance Record And Costs

Since most epoxy/polymer binder installations in New York State are recent installations (e.g., installed within the last 7 years), it is difficult to project the expected life of such treatments. The expected life will depend on the quality of the construction procedure and the traffic density to which the treatment will be exposed. Other State and local government agencies have reported that selected installations have been performing satisfactorily up to four years after installation. Based on these reports and field surveys of New York State installations, it is projected that epoxy/polymer binder applications should last a minimum of six years.¹ The thickness of the epoxy/polymer binder and how well it bonds to the pavement during installation are the key performance parameters. Table 3.2 summarizes the field survey data and other agency interview data that were used to project the expected service life of the subject treatment.

Table 3.2 Expected Service Life Estimates¹		
Product	NYS Field Surveys^{1,2}	Other Agency Interview^{1,5}
Crafco HFS	Up to 4 years	4 years ³
Tyregrip	Up to 6 years	No Data Available
TrafficDeck	Up to 5 years	No Data Available
FrictionPave	Up to 4 years	2 year ⁴
Spraygrip	Up to 4 years	No Data Available
1. All of the numbers reported here are of installations that are in continuing service. Longer periods of effective service may be anticipated. 2. NYSDOT Task Deliverable 4B, Agreement No.6764F, C-06-18, dated August 24, 2009. 3. Telephone surveys with transportation officials from the New Jersey Department of Transportation (NJDOT), Bangor ME, Braintree MA, Bennington VT, and Hartford Ct. 4. Telephone surveys with transportation officials from the Florida Department of Transportation (FLDOT) 5. NYSDOT Task Deliverable1, Agreement No. 6764F, C-06-18, dated September 15, 2008.		

The cost for treating a pavement with epoxy/polymer binder will vary depending on the size of the project, project location, and site geometry. Installed costs (2009) can be expected to range from \$2.00 to \$11.00 per square foot.²

3.2 Materials and Equipment

The epoxy/polymer binder material is a two component, cold applied, self-leveling material that consists of 100% solids that is applied at ambient temperatures. The two components are Part A, the resin component and Part B, the hardener. They are liquids that when mixed will slowly react with each other to form a hard durable solid. The binder is used in conjunction with aggregate materials that impart color and texture to the surface. Equipment required to perform the

¹ NYSDOT Task Deliverable 4B, Agreement No. 6764F, C-06-18. Dated August 24, 2009.

² Cost data supplied by representatives from five epoxy/polymer vendors (Crafco HFS, Tyregrip, TrafficDeck, FrictionPave, and Spraygrip)

installation includes texturing templates, a vibratory compactor, suitable containers, electric mixing devices, spreading tools, and various cleanup tools. An optical thermometer is also helpful in monitoring the rate and completion of the chemical reaction that occurs when the two components are properly mixed.

3.3 Construction Procedures

Treating a pavement using an epoxy/polymer binder overlays involves a series of field operations that include pavement cleaning, pavement heating, template indentation, area masking, epoxy/polymer binder placement, aggregate placement and site cleanup.

Pavement Cleaning

The existing pavement surface is initially cleaned of all loose and adhering debris, salt from previous deicing operations, and stains of grease or oil, present on the surface of the pavement. This is typically accomplished by sweeping the area with a stiff bristle broom or a power broom, and if needed (persistent debris and stains continue to adhere to the surface), the use of a power washer.

Stains of grease or oil present a particular problem. The epoxy/polymer binder material will not adhere to areas stained with petroleum products. Again, the power washer may be effective in cleaning these stains and a non-solvent based degreaser is can be employed. The non-solvent based degreaser is typically placed on the stain area and allowed to sit for a period of at least 15 minutes before it is removed by power washing. Solvents or solvent-based detergents cannot be used on HMA surfaces to remove petroleum stains since they will dissolve the asphalt binder.

Pavement Heating

If a textured surface condition is specified for HMA pavements, it is necessary to pre-heat the existing pavement and then impress a template to form the textured surface. This is accomplished, after the pavement is cleaned, by treatment with an infrared radiant heater to raise the surface temperature to at least 210 degrees F. Special care must be taken to avoid raising the temperature too high because at temperatures over 325 degrees F asphalt binder properties can be irreversibly altered. The heater is a reciprocating infrared radiant device that is mounted on a frame that allows it to be moved systematically over the work area. A scanning thermometer is used to control the temperature of the pavement.

Template Impression

Once the temperature of the surface has reached 210 degrees F, a rigid template is placed in the desired location. A vibrating compactor or other approved tool is then used to impress the template into the surface of the pavement. The size of the template is generally 3 feet by 5 feet, but this dimension may be varied for specific applications.

Area Masking

Once the pavement has been cleaned, and if texturing is not required, the area of epoxy/polymer binder application is marked out using a masking material. This is a masking tape product or other material that will insure that epoxy/polymer binder material will only be applied to the desired area and that application will be defined by lines that are consistent with the project plans.

Epoxy/Polymer Binder Mixing

Mixing of the epoxy/polymer binder material is accomplished in a mixing vessel at a temperature specified by the manufacturer. Small batch volumes of material are normally mixed because larger volumes of material can generate greater exothermic heat, possibly resulting in a spontaneous chemical reaction known as a flash set.

Epoxy/Polymer Binder Placement

Once the prescribed mixing period is completed, the material is removed from the mixer and placed in the application area. The material is subsequently spread over the application area to a specified depth of 50 mils with a serrated edged rake. The depth of application is critical to the performance of the treatment. In some cases, where the asphalt pavement surface is irregular it may be necessary to apply a preliminary layer of epoxy/polymer binder to fill and seal open pavement surfaces. After the required thickness of binder is placed, but before it starts to react and set, the required amount of aggregate material is applied to the surface. A wet appearance on the treatment surface indicates that more aggregate material is required.

The treatment typically cures for at least three hours at 70 deg. F. If the ambient temperature varies from 20 deg. F then the required cure time should be adjusted accordingly. When cured, the surface of the treatment must be swept or vacuumed to remove non- adhering aggregate particles. Areas that exhibit insufficient aggregate materials should be scheduled for repair. This repair consists of reapplying binder and aggregate components over the existing treatment or removal and total replacement of the treatment.

3.4 Inspection Procedures

Candidate Pavements

It is important that the candidate pavement be in sound condition. Any distress areas such as rutting, cracks, raveling or other anomalies should be corrected prior to the application of the treatment.

Pre-Construction Testing

Two types of preconstruction quality control tests are available. The first is designed to address architectural issues and the second engineering Issues.

Architectural Issues:

It is common practice for Contractors to prepare pre-installation samples of the specified treatment. These samples, which are prepared on a rigid frame with typical dimensions of 60 cm by 60 cm, are used as a control, to establish the expected pattern and color that will be produced in the field. The samples, which consist of a layer of either HMA or PCC (at least 37.5 cm thick) with the epoxy/polymer binder bonded to it, are prepared in the exact manner that the Contractor intends to perform the project (i.e., the construction process of heating, inlaying, installing and heating the thermoplastic panel). Preparation of such samples provides a means for the Architect or Engineer to approve the treatment prior to construction and to compare the actual field installation to the agreed-upon control sample.

Engineering Issues:

British Pendulum Number (BPN) testing (ASTM E-303) is commonly used to evaluate the friction properties of architectural pavement treatments. This can be achieved prior to construction by having the Contractor supply the Engineer with test data from an independent testing laboratory that indicates the material supplied for the project when tested in accordance with ASTM E-303 exhibits minimum skid resistance values of 52 British Pendulum Number (BPN).

Pavement Preparation

Deposits of fine-grained material or petroleum residues on the pavement will prevent proper bonding of the epoxy/polymer binder with the surface of asphalt pavements. Adequate cleaning techniques must be employed to ensure a clean surface prior to epoxy/polymer binder application. .

Epoxy/Polymer Binder Material Handling and Storage

It is important the specified epoxy/polymer binder material be delivered in sealed containers that are marked with the manufacturer's name, product name, date of manufacture, and color. The material, once delivered to the project site, should be stored out of direct sunlight and protected from the elements. The Part A and Part B markings on each container are bold and easily visible. The raw material will typically have a shelf life of at least one year.

Construction Control

Since most epoxy/polymer binder failures that occur are due to incorrect batching of component materials, particular attention should be shown to the mixing of the epoxy/polymer binder material. It is also important to monitor the mixing time. The full time for mixing is critical, since incomplete mixing is the greatest cause of epoxy/polymer binder failure. During the application of the epoxy/polymer binder, it is important to monitor that the specified binder thickness is applied. Aggregate application rates are also to be carefully monitored. After setting of the epoxy/polymer binder the bonding should be checked.

Temperature Control

During the texturing step, if required by the contract, an optical thermometer is typically used to insure that the appropriate pavement temperature is achieved. The asphalt pavement temperature should not exceed 325 degrees F.

Record Keeping

The Contractor should keep accurate records of the use of all epoxy/polymer binder materials, including the date of manufacture of the material and the lot numbers. This information is compared to the date the material is used on the project and the exact location that the material is used on the project. At the completion of the project, these records or a copy of these records should be given to the Engineer. The Contractor should also maintain an accurate log of the activities that constitute the work that is required. This should include the date and acceptability of the surface preparation, ambient temperatures (as high and low values for the days when work takes place), relative humidity, and pavement surface temperatures, prior to the placement of epoxy/polymer binder at the start, middle and end of each work day. This log should be made available to the Engineer on request and a copy should be delivered to the Engineer at the completion of the project. The Contractor should maintain a photo record of the progress of the work to include photos of the work area surface, prior to the start of surface preparation, any cracked or distressed areas that need repair, the surface prior to the placement of the epoxy/polymer binder, and the epoxy/polymer binder in place after setting.

3.5 Relevant Material Specifications

The epoxy binder material should be manufactured to the requirements of ASTM C-881 Grade 1 “Standard Specification for Two Component Epoxy Binder” or an equivalent national standard. For polymer binder, material of equivalent quality material should be used. The material should have three significant properties. First, when it has set, it must bond with the asphalt material and aggregates in the pavement. This property is measured by performing ASTM D3349, “Standard Test Method for Measuring Adhesion by Tape Test”. Generally, this test should show at least 50 % of the surface area of the bond surface of the treatment having particles of asphalt adhering. Secondly, the aggregate materials placed on the liquid epoxy/polymer binder, to impart a desired color or texture and to improve the friction properties of the treatment, must meet the requirements of the NYSDOT. Finally, the installed epoxy/polymer binder material should meet a minimum friction requirement of 52 BPN when tested in accordance with ASTM E-303, “Standard Test to Determine British Pendulum Number”.

Appendix C: NYSDOT Special Specifications

Textured Asphalt Pavement with Thermoplastic Inlay, Section 601.9402—02[1]

Surface Treatment for Pavements Type 2, Traffic Grade, Section 601.20---01[1] [1]

Integrally Colored Hot Applied Textured Polymer Wearing Surface, Section 601.03---09[1]

Textured Hot Applied Polymer Surfaces:

ITEM 601.03-09 - INTEGRALLY COLORED HOT APPLIED TEXTURED POLYMER WEARING SURFACE - COARSE AGGREGATE TYPE F2 CONDITIONS

DESCRIPTION :

Construct architectural pavement treatments for use under vehicle traffic as shown on the contract documents.

MATERIALS:

Hot applied polymer binder and natural aggregate system, approved by the Materials Bureau. Final surface must provide an initial minimum friction value of 50 BPN.

Binder:

- Designed specifically for use as a textured wearing surface for traffic conditions.
- Integrally colored as to achieve a final product meeting the color requirements of the contract.
- Provide a firm bond to concrete or asphalt.
- Provide a durable surface and texture which will not deform under traffic.

Aggregates:

Coarse Aggregates: Section 401-2.02 B. Coarse Aggregate Type F2 Conditions.

Gradation: 100% passing the 12.5 mm sieve

Submit aggregate samples to the Materials Bureau for approval 45 days prior to use.

Additional quality assurance samples will be retrieved during installation and submitted for testing at a minimum rate of 1 sample per 100m², or as ordered by the Engineer.

Fine Aggregates:

Silica sand as recommended by the pavement treatment manufacturer. Submit aggregate samples to the Materials Bureau for approval 45 days prior to use.

Use silica sand as a topping material at an application rate of approximately 50kg per 50 square meters of surface area.

Silica sand gradation requirements:

Sieve Size Percent Passing

850 µm 100

600 µm 40-100

300 µm 1-3

150 µm 0 - 0.3

CONSTRUCTION DETAILS:

Construct according to manufacturer's recommendations, using licensed or certified applicators and/or a manufacturer's representative on site during placement.

- Apply a manufacturer's recommended primer if required.
- Place the pavement treatment at the thickness shown in the contract documents.
- Interfaces with adjacent surfaces shall be flush, providing smooth transition from surface to surface.

- If the pavement treatment is placed over existing pavement, construct 20mm deep by 150mm wide keyways at all edges.
- Cut the installation boundaries prior to excavating the existing material.
- All surfaces must be dried and cleaned by use of mechanical sweepers, high pressure air or other methods approved by the Engineer prior to use.
- Surfaces must be free of all dirt, oil, debris and any other material that might interfere with the bond between the pavement treatment and existing surfaces.
- Use a hot compressed air lance (HCA) on existing surfaces immediately prior to application of the pavement treatment, to remove any remaining dust and promote good adhesion to the substrate.
- Use masking tape or other suitable material to protect the area adjacent to the installation.
- Install grade control devices to ensure the required thickness of the pavement treatment is installed.
- The method and material used for grade control must be pre-approved by the Engineer.
- Heat the pavement treatment in accordance with manufacturer's recommendations using a thermostatically controlled pre-heater capable of continuous material agitation.
- Heating of the pavement treatment by direct flame is not allowed.
- Only use heating equipment that has been approved by the Engineer.

Temperature Requirements:

- Preheat the pavement treatment between 190°C-215°C.
- Silica sand must be completely dried before application to ensure proper adhesion to the material. A hot compressed air lance may be used to thoroughly dry and preheat the silica sand.
- Do not place material when the ambient air temperature is below 4°C.
- Surface temperature must be 0°C minimum.

Do not place material if the Engineer determines atmospheric conditions may compromise the surface treatment performance.

Apply, uniformly spread and smooth out the material between the grade control forms utilizing hot irons as recommended by the manufacturer. Apply preheated sand after the material has been smoothed out and before texturing.

Surface Texture (if required):

Texture the semi molten material immediately after the sand application using an approved mold capable of providing a 6mm ± 2mm deep and wide imprint in accordance with the design details shown on the plans. Use a manufacturer approved release agent to prevent the pavement treatment from sticking to the mold.

METHOD OF MEASUREMENT:

This work shall be measured as the number of square meters of material necessary to construct architectural treatments as shown in the contract documents, or as ordered by the Engineer.

BASIS OF PAYMENT:

The unit price bid per square meter shall include the cost of all training, labor, materials, equipment and clean up necessary to complete the work.

4 January 2006

Epoxy/Polymer Binder:

ITEM 601.20 01 M -SURFACE TREATMENT FOR PAVEMENTS Type 2, Traffic Grade

DESCRIPTION:

Install a coarse surface treatment at the locations noted in the plans and in the color and texture as specified in the contract documents.

MATERIALS:

The binder/aggregate system used must be evaluated by the Department 45 days prior to use. Submit to the Department product data and MSDS sheets on the proposed system and samples of the system displaying the colors and textures specified in the contract plans. Aggregate samples shall be submitted to the Materials Bureau for approval. Provide additional quality assurance samples of aggregate and binder components during installation, for testing at a minimum rate of 1 sample per 100 square meters, or as directed by the Engineer and submit for testing.

The surface treatment must meet the following requirements:

Binder:

- Composed of a two component epoxy or other polymer binder system.
- Resist deterioration when exposed to sunlight, gasoline, oil, salt, water or adverse weather conditions.
- Shelf life of 1 year after manufacture.
- Be compatible with and provide a firm bond to the surface it is being applied to (asphalt or concrete).
- Be compatible with and provide a firm bond to the aggregates being applied to the surface.
- Not contain 0.1% or more of any chemical listed by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), or regulated by the US Occupational Safety and Health Administration (OSHA) as a carcinogen
- Comply with the volatile organic compound (VOC) requirements for traffic marking coatings as set forth in the NYS Department of Environmental Conservation's Regulation, 6NYCRR, Part 205, "Architectural Surface Coatings".
- The Manufacturer shall certify that the binder meets the following physical requirements:

EPOXY BINDER REQUIREMENTS:		
<u>Property</u>	<u>Requirement</u>	<u>Test Method</u>
Ultimate Tensile Strength	14 Mpa min.	ASTM D638
Compressive Strength	11 Mpa min.	ASTM D695
Peak Exothermic Temperature	65°C min.	ASTM D2471
Water Absorption	Less than 0.25%	ASTM D570
Shore Hardness	70 min	ASTM D2240
Bleed Test	Little trace	Swab test visual 7 days @ RT
Cure Rate	3.5 hours max.	Thin Film @ 25°C

Aggregates:

- Traffic Grade aggregates must meet Section 401-2.02 B. Coarse Aggregate Type F2 Conditions.
- Be clearly labeled and in a dry and clean condition upon delivery to the job site.
- Be maintained and stored in a dry and clean condition prior to use

CONSTRUCTION DETAILS:

Follow all exposure, respiratory and personal protective equipment controls, handling and safety precautions and spill and disposal procedures as identified by materials safety data sheets (MSDS), labels and other manufacturer's recommendations for the products used. Provide the Engineer copies of all applicable MSDS sheets and safety literature. Prepare surface and apply material according to manufacturer's recommendations and this specification. Use a manufacturer recommended primer if required.

Weather Limitations.

Do not apply binder material on a wet surface, when the ambient and/or surface temperature is below 10°C or above 35°C, or when anticipated weather conditions would prevent the proper construction of the surface treatment as determined by the manufacturer.

Surface Preparation.

- A manufacturer's representative must be on site to provide technical assistance during surface preparation, material placement and during any necessary remedial work.
- Clean existing surfaces by use of mechanical sweepers, high pressure air or other methods approved by the Engineer prior to use.
- Blastcleaning, shotblasting or use of mechanical abrading equipment may be required to clean highly contaminated surfaces.
- Receiving surfaces must be clean, dry and free of all dust, oil, debris and any other material that might interfere with the bond between the epoxy binder material and existing surfaces.
- Surfaces may need to be washed with a mild detergent, rinsed and dried using a hot compressed air lance.
- Remove any existing pavement markings as deemed necessary by the manufacturer. Adequate cleaning of all surfaces will be determined by the Engineer and the manufacturer's representative.
- Apply masking as necessary at the perimeter of the area to be treated.
- Utilities, drainage structures, curb and any other structure within and adjacent to the treatment location shall be protected against the application of the surface treatment materials.
- Cover and protect all existing joints, pavement markings and utilities prior to placement. Pavement joints must be maintained and protected.
- Damaged and/or contaminated joints shall be restored to an acceptable working condition to the satisfaction of the Engineer.
- Clean and fill all cracks in the placement area prior to treatment.

Installation.

- Place the surface treatment in accordance with manufacturer's recommended methods at the thicknesses and details as shown in the contract documents.
- Mix the binder components (A & B) at the proportions specified by the binder manufacturer using a method which produces an evenly mixed, homogenous product.
- Mixing may be done using a low speed high torque drill fitted with a helical stirrer or with an automated system.
- A preliminary layer of epoxy may be required to properly fill in open pavement surfaces.
- Evenly spread the binder with serrated edge squeegees or with an automated system.
- The mixed components may be machine or hand applied onto the cleaned surface at the coverage rate specified by the manufacturer.
- Use an automated binder mixing and spreading system for single placement areas greater than 500 Square meters.
- Uniformly distribute the binder over the section to be treated and within the temperature range specified. Proceed in such a manner that will not allow the binder material to chill, set up, dry, or otherwise impair retention of the aggregate. Care must be taken when applying binder to sloped surfaces, uniform thickness must be maintained over the entire placement area.
- Machine applied distributing equipment shall include accurate measuring devices and/or calibrated containers and thermometers for measuring the binder temperature prior to placement.
- Immediately apply the appropriate aggregate at the rate recommended by the manufacturer to achieve the required density and texture. No exposed "wet spots" of binder shall be visible once the aggregate is placed.
- Protect all utilities, drainage structures, curb and any other structure within/ adjacent to the treatment location, against the application of the surface treatment materials. Any damage shall be repaired to the satisfaction of the Engineer.

Curing.

Allow the treatment to cure in accordance with manufacturer recommendations, approximately 3 hours at an ambient temperature of 20 C, remove the excess aggregate by hand or suction sweeping before opening to traffic. Additional sweeping may be necessary after the system fully cures.

Acceptance Evaluation.

Within 90 days after construction of the surface treatment, or prior to contract acceptance, whichever comes first, the Department will evaluate that the aggregate coverage is complete and there is no exposed binder visible. Areas containing exposed binder will be repaired according to manufacturer's recommendations at no additional cost to the State.

METHOD OF MEASUREMENT:

This work shall be measured as the number of square meters of surface treatment material satisfactorily installed as shown in the contract documents, or as directed by the Engineer.

BASIS OF PAYMENT:

The unit price bid per square meter shall include the cost of all labor, materials and equipment necessary to complete the work.

Payment will be made under:

Item No.	Item Pay	Unit
601.20 01	Surface Treatment for Pavements Type 2, Traffic Grade	Square Meter

2 July 2008

Textured Thermoplastic Inlay:

ITEM 601.9402 02 - TEXTURED ASPHALT PAVING WITH THERMOPLASTIC INLAY

DESCRIPTION:

Furnish and install and inlaid thermoplastic pavement system on hot mix asphalt (HMA) at the areas noted on the project plans and in the color specified.

MATERIALS:

The system must be approved by the Landscape Architecture and Materials Bureau according to department directives.

Thermoplastic:

Must meet the following requirements:

- 2 year shelf life from date of manufacture.
- Be a mixture of high quality polymeric materials, pigments, and glass beads, with a reflective layer of glass beads bonded to the top surface.
- Resist deterioration when exposed to sunlight, gasoline, oil, salt, water or adverse weather conditions.
- Provide an initial minimum skid resistance value of 52 to 62 British Pendulum Number (BPN) when tested according to ASTM E-303.
- Softening point range between 100° and 120 ° C when measured by the Ring and Ball method as described in ASTM D-36-95(2000).
- Be Stored in a cool (21°C +/- 3°C) dry area indoors
- Provided as pre-cut panels in sizes to conform to the specified pattern, widths and shapes.
- Packaged in accordance with accepted commercial standards.

EQUIPMENT:

A. Reciprocating Infra-Red Heating Equipment: Designed to apply heat to the asphalt surface to make the upper portion of the asphalt surface pliable enough to accept the imprint of the template and allow continuous monitoring of the surface temperature to ensure the asphalt does not over heat and burn.

B. Vibratory Plate Compactor: For pressing the templates into the heated asphalt to create the specified pattern.

C. Templates: Providing the imprint design as detailed on the drawings and specifications.

QUALITY OF ASPHALT PAVEMENT:

The asphalt pavement in the area to receive the inlaid thermoplastic shall meet or exceed the mix design standards recommended. The asphalt pavement shall be stable and well compacted. Deficiencies in preexisting asphalt pavement such as ruts, raveling, cracks, or the like shall be

corrected to the satisfaction of the Engineer, prior to installing the in-laid thermoplastic. Surface to be stamped and inlaid must be clean and free of contaminants prior to installation.

CONSTRUCTION DETAILS:

Install according to manufacturer's recommendations and this specification.

A. Layout and imprint the pattern into the surface of the HMA as per the drawings and/or specifications.

Coordinate the installation with the contractor and applicator.

B. Apply heat to pre-existing asphalt surface using equipment meeting the requirements of this specification. Direct flame heaters and non-reciprocating heaters are not allowed to be used for this purpose, except in transition areas and for spot treatment. Do not allow reheating operations to cause the pavement temperature to exceed 163 °C.

C. Clean equipment used for the inlaid operation in accordance with subsection 402-3.12 Paver and Equipment Cleaning.

D. Once the asphalt has reached imprinting temperature, place the templates in position and press into the surface using vibratory plate compactors. Imprint to a depth equal to or greater than the thickness of the thermoplastic being inlaid.

E. Place the pre-cut thermoplastic panels in position on completely dry asphalt, within the imprinted area. Re-apply heat to the surface using reciprocating infrared heaters, slowly raising the surface temperature until the thermoplastic material in the panels start to liquefy and flow, but no higher than 163° C. Once the thermoplastic material has liquefied, remove the heat source and allow the surface to cool.

METHOD OF MEASUREMENT:

The installation of the inlaid thermoplastic pavement system will be measured by the number of square meters of HMA satisfactorily inlaid in accordance with this specification and as approved by the Engineer.

BASIS OF PAYMENT:

The unit price bid per square meter shall include the cost of furnishing all labor, materials, equipment and tools necessary to complete the inlaid work. The HMA and any related repair work will be paid separately.

2 July 2008