DIVISION 420 – PAVEMENT SURFACE TREATMENTS

THE FOLLOWING IS ADDED:

SECTION 423 – HIGH FRICTION SURFACE TREATMENT

423.01 DESCRIPTION

This section describes the requirements for furnishing and placing a High Friction Surface Treatment (HFST) on an asphalt or concrete pavement surface.

423.02 MATERIALS

423.02.01 Materials

Provide materials as specified:

High Friction Surface Treatment 912.05

423.02.02 Equipment

Provide equipment as specified:

Mechanical Sweeper 1008.03
Hot-Air Lance 1008.06
Manual HFST Application Equipment 1012.03
Truck Mounted HFST Application Equipment 1012.04
Portable Shot Blast Equipment 1012.05

Provide an air compressor that filters oil and moisture from the air and delivers air at a minimum of 180 cubic feet per minute.

Use Truck Mounted HFST Application Equipment. For projects with areas not accessible with truck mounted HFST application equipment, the Contractor may use manual HFST application equipment for HFST installation.

Provide any equipment as required by the HFST manufacturer to ensure proper cleaning and application rates of binder resin and aggregate. Provide depth gauge to measure wet binder resin thickness.

423.03 CONSTRUCTION

423.03.01 HFST

A. HFST Plan. At least 20 days before beginning placement of HFST, submit a detailed quality control plan to the RE for approval that includes the following:

1. HFST product, manufacturer, required material components of the HFST, MSDS, handling and installation guidelines, weather limitations and Material Quality Control plan. The test results of the HFST aggregate and binder resin system from an independent testing laboratory.
2. HFST contractor's superintendent and crew. Provide superintendent and crew qualifications with a list of at least five successful HFST projects, with references, within the last 3 years, demonstrating the minimum skid resistance of 65 when tested in accordance with ASTM E 274. Include each project owner and contact information.
3. Number, type, model of equipment and material control/metering devices along with the current calibration documentation.
4. Sequence and procedures for maintaining continuous operation as specified.
5. Quality Control Plan with sampling and testing frequency/type for each material and construction operation.

6. Method of locating, protecting and maintaining manholes, inlets, other utilities and RPM's.
7. Schedule, hours of operation, and production rates for the project.
8. Storage locations for aggregate and binder resin components.
9. Method of constructing joints and transitions for HFST.
10. Lighting plan for nighttime operations as specified in 108.06.

Do not begin HFST installation until the RE approves this plan. Any deviation from the approved plan will require approval by the RE, or the RE will suspend operations. Submit an adjusted HFST plan to the RE for approval before adjusting the HFST operation.

B. Weather Limitations. Do not place HFST if the surface temperature of the underlying pavement is below 55 °F or if the National Weather Service is forecasting temperatures below 55 °F during HFST installation or within 3 hours after installation. Do not place HFST if the ambient temperature is above 105°F.

Immediately prior to placement, ensure the surface is completely dry. Do not place HFST if the existing surface is wet or shows any signs of moisture presence in the surface. Do not place HFST if it is precipitating or if precipitation is imminent. If within the 3 hours of HFST, the National Weather Service locally forecasts a 40 percent chance, or greater, of precipitation during the scheduled placement, then postpone the placement of HFST. The Contractor may resume HFST operations when the chance of precipitation is less than 40 percent, and the surface is dry.

Do not apply the polymer binder when the anticipated weather conditions would prevent the proper application of the surface treatment as determined by the manufacturer's representative.

C. Test Strip. Construct a test strip of at least 100 feet in length on the project before initial placement commences. For installation quantities less than 300 square yards on a single project, the test strip is the first day of HFST installation. Ensure the test strip is performed during weather and sunlight conditions that are representative of project production placement of the HFST. While constructing the test strip, record the following information and submit to the RE:

1. **Weather Conditions.** Document the wind speed, amount of direct sunlight and humidity at the time of placement. Measure the surface temperature of the existing pavement and the ambient temperature at the beginning and end of each day's HFST operation.
2. **Binder Resin Calibration**. Measure to verify the proper application rate and coverage of binder resin for compliance. Provide a printout of the quantities of each binder resin component to ensure compliance with the manufacturers specified proportions and tolerance.
3. **Aggregate Calibration.** Measure to verify the proper application rate of the aggregate for compliance. Provide a printout of the aggregate quantity from the HFST equipment to ensure calibration.
4. **Initial Set Time.** Record the initial time of placement and the time when the HFST sets.
5. **Cleanup.** After curing is complete, clean up excess stone using a mechanical sweeper to the satisfaction of the RE. Hand sweeping may be used in areas inaccessible to a mechanical sweeper. Cleanup any excess binder. Notify the RE when cleanup is complete.
6. **Performance Under Traffic.** After cleanup is complete, allow traffic for a period of at least 24 hours. Verify that the HFST shows no visual signs of distress when exposed to traffic. The RE will visually survey the HFST and verify the test strip meets the surface quality requirements as specified in 423.03.01.G.
7. **HFST Quality Control Verification.** Verify the HFST construction quality by measuring texture depth and HFST cured binder thickness according to the HFST manufacturer's requirements and this specification. Measure the following parameters in the presence of the RE:
    a. **Mean Texture Depth Verification.** The RE will select and mark 2 random locations for testing mean texture depth. In the presence of the RE, measure the mean texture depth of the HFST according to ASTM E 965. Ensure that the mean texture depth of the HFST is at least 1.0 mm minimum. Provide the results to the RE.
    b. HFST Thickness Verification. Take pavement core samples of the HFST in each of the locations where the mean texture depth tests were performed. Measure and record the thickness of the HFST according to NJDOT D-1. Ensure that the HFST thickness is between 120 mils minimum and 200 mils maximum. Provide the results and core samples to the RE.

Submit test strip results to the RE. The RE will analyze the test strip results and visually inspect the test strip. The RE will visually inspect the test strip after it has been open to traffic for at least 24 hours. If the HFST does not meet the requirements as specified in 423.03.01.G or the quality control verification in 423.03.01.C.7, then the RE will reject the test strip. Submit a corrective action plan to the RE for approval. When the RE approves the corrective action plan, then construct a second test strip. If the second test strip does not meet requirements, suspend HFST operations until written approval to proceed is received.

Do not proceed with production placement of the HFST until receiving written permission from the RE.

Before making adjustments to the HFST operations, notify the RE in writing. The RE may require a new test strip to verify the performance of the adjusted HFST operations.

D. Surface Preparation. Ensure all repairs are completed prior to beginning HFST installation. Allow full or partial depth concrete and asphalt repairs to cure at least 30 days before the placing the HFST. Seal cracks greater than 1/4 inch and less than 1-1/2 inch in width with an approved crack sealant or the approved blended HFST binder resin. For applications on newly constructed concrete or asphalt pavements, ensure that the installation of the HFST is at least 30 days after construction of the pavement. If required by plan, remove traffic stripes and thermoplastic traffic markings according to 610.03.08.

Ensure that manholes, inlets, utilities, curbs, RPM's, structures, rumble strips, traffic striping and traffic markings to remain are protected from the HFST by methods approved by the RE.

Shot blast concrete pavement surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. Ensure that the prepared surface complies with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5.

Clean the surface of the pavement to remove all dust, debris, oil, and any other materials that may prevent bonding of the HFST. Ensure that the surface is clean and dry before starting HFST application. Do not proceed with placement of the HFST until the RE approves the prepared surface.

E. HFST Application. If required by the HFST manufacturer, prepare and apply the prime coat prior to applying binder resin according to the manufacturer's instructions. Proportion the binder resin system components to the correct ratio within +/- 2% by weight and thoroughly mix for the mixing time specified by the manufacturer.

Ensure the blended binder resin used to seal any cracks has gelled before proceeding with HFST installation. Apply the blended HFST binder resin over the area uniformly at an application rate of between 0.28 to 0.35 gallons per square yard or as required to provide a uniform thickness of 50 to 65 mils of wet binder resin. Ensure proper coverage of wet binder resin and verify using a depth gauge. Provide depth gauge measurement readings to the RE as directed. Ensure the binder resin is applied neatly and cleanly. Ensure no contamination, disturbance or loss of the wet binder resin occurs during installation. Ensure that any blushing (waxy surface coating on the binder resin) caused by a reaction of moisture with the hardening agent does not occur during the application process. Remove any areas that show signs of blushing. Correct any areas not properly covered, contaminated or disturbed as directed by and to the satisfaction of the RE. If mechanical application equipment is used, take 2 ounce samples for each 100 gallons of resin placed to verify mix ratios and curing times. Place samples at the roadway shoulder and ensure that the gel time is within proper range in accordance with the manufacturer's recommendation.

Ensure the HFST aggregate is applied uniformly at a rate of 12 to 15 pounds per square yard, or as recommended by the HFST manufacturer, immediately after placement of the wet binder resin. Ensure that the wet binder resin is completely covered with the aggregate. Ensure the aggregate is placed in a manner that does not disturb the wet binder resin thereby reducing the binder resin film thickness in any location. Ensure the wet binder resin is completely and uniformly covered with aggregate before the binder resin gels, or within a time period of not more than 5 minutes after binder resin is applied, whichever is less. Perform quality control testing as outlined in the Quality Control Plan to ensure the HFST quality is consistent with the approved test strip.

If approved by the RE, reuse of recovered bauxite aggregate will be allowed only once. Blend the recovered bauxite with new bauxite at a rate of 2:1 (two parts of new bauxite to one part of recovered bauxite).

On grooved concrete surfaces, apply two layers of HFST to achieve the required mil thickness for adequate bonding to the existing surface. When placing in multiple lifts, ensure that the aggregate used for each lift meets the requirements in 423.02.01 and ensure all aggregate is properly embedded into the binder resin.

Provide a summary of material quantities to the RE at the end of each work shift. If requested by the RE, provide texture depth and binder thickness verification quality control results according to ASTM E 965 and NJDOT D-1, respectively.

F. Opening to Traffic. Allow the material sufficient curing time, at least 3 hours or as recommended by the manufacturer, before opening to traffic. Sweep to remove loose and excess aggregate by methods approved by and to the satisfaction of the RE before opening to traffic.

G. Surface Quality Requirements. Ensure that there is no excess buildup, uncovered areas, or rough areas on the HFST including the longitudinal or transverse joints

The RE will visually inspect the HFST for approval. If the HFST does not have sufficient aggregate cover, is delaminated, or has excess aggregate material, the RE will reject the HFST. Correct any areas of the HFST that the RE rejects. Visual inspection by the RE is considered sufficient grounds for such rejection.

H. Skid Resistance Requirements. The Department will evaluate the HFST for Skid Resistance according to ASTM E 274 with the ribbed tire. The minimum skid number (SN) for the HFST is an average of at least 65 and no single skid number less than 60. If the average skid resistance is less than 65 or any single skid number is less than 60, submit a plan for corrective action to the Department. If the corrective action plan is approved and the HFST is corrected, the Department will retest and evaluate the corrected area that is subject to the same requirements as the initial work. If the Contractor's plan for corrective action is not approved, the Department may require removal and replacement. The replacement work is subject to the same requirements as the initial work.

I. Maintenance Bond. Upon completion of HFST and opening to traffic, provide a maintenance bond equal to 100% of the contract value of the HFST, including permits, maintenance and protection of traffic, and all other work items incidental to the HFST work, such as traffic stripes, traffic markings or others. Ensure the bond is in effect for three years from the completion of the HFST. Ensure the bond is properly executed by a surety company satisfactory to the Department and is payable to the State of NJ. Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the HFST continues to meet or exceed the requirements in 423.03.01.I.2. At the end of the three-year maintenance bond period, the Contractor will be released from further work and responsibility, provided previously requested HFST repair work has been satisfactorily completed and approved by the Department. Ensure maintenance work is accomplished as specified in the following:

1. **Maintenance Bond Work.** Review the HFST Evaluation report and provide a remediation plan to the Department describing the repair work, including a revised Quality Control Plan to ensure performance. All repair work must meet the same requirements as the initial work. Obtain required permits and approvals from the Department prior to proceeding with any bond work or monitoring.
   a. **Scheduled Bond Work**. During the bond period, perform bond work at no cost to the Department at locations and in quantities based on the results of HFST evaluation report. Perform repair work according to the approved remediation plan. During the bond period, the Contractor may monitor the warranted HFST using non-destructive procedures. The Contractor, without prior approval of the Department, may not perform coring, milling or other destructive procedures on the HFST. The Contractor will not be responsible for damages to the pavement due to coring, milling or other destructive procedures conducted by the Department. The Contractor will have the first option to perform the repair work.
   b. **Emergency Bond Work.** If, in the opinion of the Department, the HFST exhibits distress that requires immediate repair for safety of the traveling public, then the Department will notify the Contractor to perform emergency repair work. If the contractor does not perform the repair work within 48 hours, then the Department will perform the work or have the work performed by others. The Contractor is responsible to pay for costs incurred by the Department for emergency repair work performed on the HFST by the Department and by others. Repair work performed by others will not alter the requirements, responsibilities, or obligations of the maintenance bond.

2. **HFST Evaluation Report.** Each year after HFST completion and at the end of the maintenance bond period, the Department will perform a HFST Distress Survey, Skid Resistance Survey, and if required, request a repair plan**.** The Department will visually survey the HFST for distress and evaluate skid resistance as specified in 423.03.01.H. The Department will use the following distress and skid resistance threshold values defined herein throughout the bond period:

a. **HFST Distress Survey.** The Department will survey the HFST to measure, locate, and report areas of raveling and delamination. Raveling is the wearing away or dislodging of the HFST aggregates. Delamination is the loss of HFST aggregate and/or HFST binder that has debonded from the underlying pavement substrate. The Department will measure raveled and delaminated HFST in rectangular areas oriented parallel and perpendicular to the traffic striping. The Department will measure the length of raveled and delaminated areas parallel to the roadway traffic striping from the outermost points of the distressed area(s). The Department will measure the width of raveled and delaminated areas perpendicular to the traffic striping from the outermost points of the distressed area(s). The threshold values of raveling and delamination which will require repair are 1 square feet for a single location and 4 square feet for the sum of multiple locations, respectively.

b. **Skid Resistance Survey.** The Department will perform a skid resistance survey as specified in 423.03.01.H. If measured skid resistance of the HFST is below threshold values, then the Department will require repair. The threshold values of skid resistance that will require repair action are an average skid number of less than 65 and any single skid number less than 60.

Upon completion of each HFST evaluation, the Department will issue a written report to the contractor detailing deficient sections of HFST that fail to meet the requirements and indicate if and where HFST repair is required.

Within 30 days of receipt of the HFST evaluation report, submit to the Department for approval a repair plan and work schedule to address deficient sections of HFST. Once the repair plan and work schedule is approved, ensure repair work is performed within 30 calendar days of approval.

If, anytime during the bond period, 30% or more of the project requires, or has received repairs, the Department may require the entire HFST to be removed and replaced. The conflict resolution team will make a final recommendation.

If repair work or elective/preventive action work performed by the Contractor necessitates a corrective action to the pavement markings, adjacent lanes or roadway shoulders, such corrective action to the pavement markings, adjacent lanes, and shoulders will be the responsibility of the Contractor.

Bond requirements for remediation work will be limited to the life of the original contract bond.

If the allowable distress quantity is exceeded and the Contractor does not agree with the HFST evaluation report or the Department does not agree with the proposed repair plan, the conflict resolution team will provide a recommendation within 30 calendar days.

If the HFST was installed as specified, then the Contractor will not be held responsible for distresses that are caused by failures of the underlying pavement below the HFST. The Contractor is responsible for materials durability and workmanship of the HFST during the maintenance bond period.

3. **Conflict Resolution Team.** The scope of work for the conflict resolution team includes issues concerning the bonded HFST relative to the quality control plan, material selection, HFST evaluations, distress thresholds, repair plans, and repairs. The team will consist of two Contractor representatives, two Department representatives, and a fifth person mutually agreed upon by both the Department and the Contractor. Costs for the fifth person will be equally shared between the Department and the Contractor. The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this bond and the methods used in the measurement and calculation of HFST distress repair areas. The team will render a final recommendation by a majority vote. Each member has an equal vote.

4. **Elective/Preventive Action.** The Contractor may perform elective or preventive action with prior approval from the Department.

5. **Department Maintenance.** The Department will perform routine maintenance operations during the bond period such as plowing, applying de-icing chemicals, repairs to safety appurtenances, pavement markings, mowing, and sign maintenance. The Department may perform minor pavement repairs such as pothole repair due to underlying pavement failure and crack sealing.

6. **Final Bond Acceptance.** The Department will review the project in the field for any distress not addressed in the indicators and recommend a Final Bond Acceptance. The Department will issue the Contractor a Final Bond Acceptance letter.

423.04 MEASUREMENT AND PAYMENT

The Department will measure and make payment for the Items as follows:

Item	*Pay Unit*
HIGH FRICTION SURFACE TREATMENT	SQUARE YARD
HIGH FRICTION SURFACE TREATMENT MAINTENANCE BOND	LUMP SUM

The Department will make payment for REMOVAL OF TRAFFIC STRIPES and REMOVAL OF TRAFFIC MARKINGS as specified in 610.04, except the Department will not make payment for REMOVAL OF TRAFFIC STRIPES and REMOVAL OF TRAFFIC MARKINGS associated with Maintenance Bond work.

The Department will not make pay adjustment for any corrective work performed as required by the Maintenance Bond specified in 423.03.01.I.

DIVISION 900 – MATERIALS

SECTION 912 – PAINTS, COATINGS, TRAFFIC STRIPES, AND TRAFFIC MARKINGS

THE FOLLOWING IS ADDED:

912.05 High Friction Surface Treatment

Provide high friction surface treatment components conforming to the following:

1. HFST Binder Resin. Provide a polymer modified or methyl methacrylate binder resin system that is specifically designed and recommended by the manufacturer as suitable for HFST use for highway travel lanes and the potential range of atmospheric exposure in New Jersey. If required by the binder resin system manufacturer, provide a prime coat approved by the manufacturer that is compatible with the binder resin system. Ensure the binder resin system conforms to the requirements as specified in Table 912.05-1.

Table 912.05-1 Physical Requirements of the Binder Resin System

Property	Test Method[1]	Requirements	
		Polymeric Resin	Methyl Methacrylate Resin
Ultimate Tensile Strength[5] (psi)	AASHTO M 235M/M 235	2,500 - 5,000	1,500 - 5,000
Elongation at break point[5]	AASHTO M 235M/M 235	30 - 70%	30 - 70%
Compressive Strength[5] (psi)	ASTM C 579	1,000 psi at 3 hours 5,000 psi at 7 days	1,000 psi at 3 hours 2,000 psi at 7 days
Water Absorption	AASHTO M 235M/M 235	1.0% maximum	1.0% maximum
Durometer Hardness[5] (shore D)	ASTM D2240	60 - 80	40 - 75
Viscosity[2] (Poises)	ASTM D 2556	7 - 30	12 - 20
Gel Time[3] (minutes)	AASHTO M 235M/M 235	10 minimum	10 minimum
Cure Rate[4] (hours)	ASTM D 1640/D1640M	3 maximum	3 maximum
Bond Strength @ 24 hours	ASTM C1583	250 psi minimum or 100% substrate failure	250 psi minimum or 100% substrate failure

1. Prepare samples per manufacturer's recommendation
2. Viscosity – prepare one pint sample and mix for 2 to 3 minutes before testing. Use X1.1 for spindle selection and test at a temperature of 73 ± 2°F.
3. Gel Time – Prepare a 60 g sample per manufacturer's recommendation. Perform testing at a temperature of 73 ± 2°F.
4. Cure Rate – Prepare specimens of 50-55 wet mil thickness.
5. Cure the following test specimens for 7 days at 73 ± 2°F, and test immediately without delay:
    a. Durometer Hardness – Use the type 1 precision type D method.
    b. Compressive Strength – Prepare specimen according to Method "B", 2" x 2" cube, using 2.75 parts of sand to one part mix polymer resin by volume. Sand must conform to ASTM C778, 20-30 sand.
    c. Ultimate Tensile Strength Prepare Type 1 specimens in accordance to ASTM D638.
    d. Elongation at break point – Prepare Type 1 specimens in accordance to ASTM D638.

Ensure that the binder resin is packaged in suitable well sealed containers and labeled as to the type of material and the ratio of components to be mixed by volume. Include any special instructions regarding

mixing. Label the components including brand name, name of manufacturer, lot or batch number, temperature range for storage, expiration date and the quantity contained therein. Include caution warnings regarding the handling, and contact with skin and eyes. Label the volumes of the pails or containers in US gallons to assist in proper mixing dosage and application rates. The ME may sample the binder resin components to test for compliance.

Provide a certification of compliance from the manufacturer of the binder resin for each container as specified in 106.07. Certify that the binder resin is appropriate for the intended use. Include in the submittal the test results from an independent testing laboratory and that the binder resin system meets the requirements in Table 912.05-1.

2. HFST Aggregate. Use fine aggregate of manufactured calcined bauxite stone sand that is clean, dry, and free of deleterious material. Ensure the aggregate meets the requirements as specified in Table 912.05-2 and Table 912.05-3.

Table 912.05-2 Requirements for HFST Aggregate

Property	Test Method	Requirement
Polish Stone Value	AASHTO T 279	38.0 minimum
Resistance to Degradation[1]	AASHTO T 96	20.0% maximum
Moisture Content	AASHTO T 255	0.2% maximum
Aluminum Oxide[2]	ASTM C 25	87% minimum

1. For Resistance to Aggregate Degradation test, use grading "D" in AASHTO T 96.
2. For Aluminum Oxide content use section 15 of ASTM C 25.

Table 912.05-3 Gradation Requirements for Fine Aggregate used for HFST

Sieve Size	Percent Passing
No. 4	100
No. 6	95 - 100
No. 16	0 - 5

Provide a certification of compliance from the manufacturer as specified in 106.07. Certify that the bauxite aggregate is appropriate for the intended use. Include in the submittal the test results and a certification by an independent testing laboratory that the bauxite aggregate meets the requirements in Tables 912.05-2 and 912.05-3.

The ME will sample fine aggregate at a frequency of 10 pounds for each 500 tons.

The RE or ME may reject fine aggregate and require disposal of any batch or shipment that is rendered unfit for its intended use due to contamination or unsatisfactory visual inspection. Visual inspection of the material by the RE or ME is considered sufficient grounds for such rejection.

DIVISION 1000 – EQUIPMENT

SECTION 1012 – PAVEMENT SURFACE TREATMENTS EQUIPMENT

THE FOLLOWING IS ADDED:

1012.03 Manual HFST Application Equipment.

Provide a low speed high shear drill fitted with a helical mixer capable of mixing the binder resin system components to the manufacturers specifications. Provide serrated edge type squeegees designed specifically for applying the binder resin uniformly over the existing pavement at the specified minimum application rate of 0.3 gallons per square yard. Provide aggregate spreading tools as required for immediately spreading the HFST aggregate, within the maximum allowable time after binder resin is applied, as specified by the HFST manufacturer.

1012.04 Truck Mounted HFST Application Equipment.

Provide truck mounted HFST application equipment with fully automated, electronically controlled, self-propelled truck mounted equipment designed and manufactured for installing HFST binder resin and aggregates simultaneously. Ensure the HFST equipment is capable of continuously and thoroughly mixing the binder resin components to the HFST manufacturer's recommended ratio and tolerance. Ensure the equipment is adjustable to meter quantities of each material as required and capable of applying mixed binder resin, at a minimum coverage rate of 12 gallons per minute, and then immediately spreading the HFST aggregate uniformly at a minimum rate of 14 pounds per square yard over the wet binder resin. Provide calibration documentation to the RE. Ensure that the documentation includes an individual calibration of each material at various settings that can be related to the machine metering devices. Ensure the equipment provides a printout of materials quantities. Any equipment repair affecting material proportioning requires that the machine be recalibrated. Do not use equipment on the project until the calibration has been completed and accepted by the RE.

1012.05 Portable Shot Blast Equipment.

Provide portable shot blast equipment that utilizes recyclable steel shot as an abrasive and includes a dust collection system to provide dust free operation. Ensure equipment has moisture and oil traps, in working order, of sufficient capacity to remove contaminants from the air and prevent oil or other contaminants from being deposited on the roadway surface. Ensure the equipment has an adequate air-cooled power source with a heavy duty hydrostatic transmission for variable speed operation, a variable abrasive valve for controlling the depth of cut, a small turning radius for maneuverability and a single switch one-man operation with forward and reverse capabilities. Ensure the equipment has an operating speed range of 0 to 160 feet per minute and a forward/reverse travel speed range of 0 to 350 feet per minute. Ensure the shot feed rate is variable from 0 to 700 pounds per minute and the shot hopper capacity is at least 200 pounds.

NJDOT TEST METHODS

THE FOLLOWING IS ADDED:

NJDOT D-1 – MEASURING THICKNESS OF HIGH FRICTION SURFACE TREATMENT (HFST) OR HIGH FRICTION CHIP SEAL (HFCS)

A. **A. Scope.** This test method is used to measure the thickness of HFST or HFCS layer from drilled HMA core samples.

B. **Apparatus.** Use the following apparatus:

1. Caliper device or ruler equipped with illumination and magnification of at least 10x to measure the axial lengths of individual lifts to the nearest 0.01 inch mounted on a support.
2. Support designed to hold the specimen with its axis in a horizontal position by 2 metal roller bearings sufficiently rigid and stable to maintain alignment without distortion or deflection.
3. Gauge to calibrate and check the zero reference point of the apparatus.

Ensure that the apparatus accommodates specimens from 1/2 to 12 inches in length.

C. **Procedure.** Perform the following steps:

1. If the caliper device is electronic, turn it on. Ensure that the caliper device is zeroed and set to the correct units of measure.
2. Place the specimen in the measuring apparatus with the smooth end of the core, which is the top or upper surface of the pavement, firmly against the zero reference point.
3. Take 4 length measurements approximately 90 degrees apart around the circumference of the specimen using the caliper device to measure the distance from the zero reference point (top of the core) to the bottom of the first lift. If a measuring point is not representative of the plane of the core lift because of a small projection or depression, rotate the specimen slightly about its axis and take the measurement at the nearest representative point.
4. Read each of the 4 measurements for the lift to the nearest 0.01 inch. Calculate the average of the 4 measurements for the lift to the nearest 0.01 inch and record.
5. Repeat Steps 3 and 4 for each lift to be measured by measuring from the zero reference point (top of the core) to the bottom of the lift being measured.

D. **Report.** Report the following to the nearest 0.01 inch:

1. Average thickness of the first lift, which is the average distance for the first lift as determined in Step 4.
2. Average thickness of the second lift, which is determined by subtracting the average thickness for the first lift from the distance measured in Step 4 for the second lift.
3. Average thickness of subsequent lifts, which is determined by subtracting the average thicknesses for all preceding lifts from the average distance measured in Step 4 for the lift.