DIVISION 400 BITUMINOUS PAVEMENTS

Table of Contents

SECTION 401 HOT-MIX, HOT-LAID BITUMINOUS CONCRETEPAVEMENT

401.01 Description. This work consists of constructing hot-mix, hot-laid bituminous concrete bases and surface courses on either a prepared foundation or an existing surface course.

401.02 Materials. Materials for hot-mix, hot-laid bituminous concrete shall conform to Section 823. Tack coat shall conform to Section 811. Sand for protection of traffic shall conform to Section 804.

401.03 Delivery of Mixture. The mixture shall be delivered at the spreader with a temperature loss not greater than 11 C from the temperature measured at the plant by the Engineer's representative.

A minimum of 90 metric tons of hot-mix bituminous concrete per hour shall be delivered to the Project site unless otherwise directed.

EQUIPMENT

401.04 Hauling Equipment. Trucks used for hauling bituminous concrete shall have tight, clean, smooth metal beds which have been thinly coated with an emulsified oil, soap solution, or other approved release agent to prevent adherence of the bituminous mixture to the bed of the truck. Each truck shall have a securely fastened cover of canvas or other suitable waterproof material that covers the bed from front to back and over the sides. The front of the tarp shall be securely fastened to the body or protected by an airfoil. The cover shall have at least three straps to a side and two straps on the back to prevent the cover from ballooning up, to protect the mixture from the weather, and to prevent heat loss. In addition, from September 30 through March 31, the truck bed shall be insulated on the front, sides, and back with plywood or other suitable material. Trucks with heated bodies may be used subject to the approval of the Engineer. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed by sunset unless approval for nighttime paving has been granted by the Engineer.

401.05 Pavers. Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly, heated, and capable of spreading and finishing asphalt concrete in lane widths of the specified typical section and thickness shown on the Plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The front of the screed or strike-off assembly shall be equipped with an automatic control device that produces a finished surface of the required evenness and texture without segregation, tearing, shoving, or gouging the mixture. The paver shall be capable of operation at forward speeds consistent with satisfactory laying of the mixture. Stop and go operations of the paver shall be avoided. Equipment used for shoulders and similar construction shall be capable of spreading and finishing the courses in widths shown on the Plans.

The screed of the paver shall be regulated by an automatically controlled grade leveling and slope control device. The device shall be adapted to the type of paver used, and shall provide control for producing a uniform surface to the established grade and a cross slope conforming to the requirements of the typical section. The device shall also be

equipped with the necessary controls to permit the operator to adjust or vary the slope throughout superelevated curves. Grade control shall be accomplished using a sensor following a traveling reference plane not less than 9 m in length. If deemed necessary by the Engineer, a joint matching shoe referencing to an adjacent mat shall be used.

If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained. Manual operation will be permitted for constructing irregularly shaped and other areas as approved by the Engineer. If the Contractor fails to obtain and maintain the specified surface tolerance, the paving operation shall be suspended until satisfactory corrections, repair, or equipment replacements are made.

401.06 Rollers. Rollers shall be self-propelled, static or vibratory steel wheel type or a combination thereof, or the pneumatic-tire type. All rollers shall be capable of reversing without backlash, and shall be operated according to manufacturer's recommendations. Steel wheel rollers shall be equipped with scrapers. Pneumatic-tire rollers shall be of the oscillating type, equipped with smooth tires of equal size, diameter, and ply rating, all maintained at the same inflation pressure. Rollers shall have a system for moistening each wheel or roller. The number and weight of the rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Using equipment that results in excessive crushing of the aggregate or marring of the pavement surface will not be permitted.

All rollers shall be approved prior to use. The rollers shall be maintained in a satisfactory working condition, and shall bear the manufacturer's nameplate stamped with the model number and the weight without ballast.

CONSTRUCTION METHODS

401.07 Application of Tack Coat. A tack coat diluted with 50% water shall be applied on all dry and broom cleaned Portland cement concrete and bituminous pavement surfaces. Tack coat shall be applied at a rate of 0.23 to 0.68 L/m^2, at a temperature of 21 to 71 C. The application rate appropriate for the surface being overlaid shall have prior approval of the Engineer. The tack coat should be a thin, uniform coating sufficient to bond the overlay to the underlying pavement. Tack coat shall be applied using pressurized distributing equipment with a spray bar or other approved distribution system. Tack coat shall be applied in advance of the hot-mix operation, but no further than is anticipated for the current day's hot-mix operation.

All contact surfaces of curbing, gutters, manholes, and other facilities shall be coated with a uniform coat of hot asphalt cement (tack) or other approved bituminous material just before the mixture is placed.

401.08 Placing Bituminous Mixtures. Prior to the delivery of the mixtures on the job, the underlying course shall have been brought to line, grade, and cross-section, and all excess patching material, joint material, dirt, and foreign material shall be removed. The mixtures shall be placed only upon a surface that is dry, and only when weather conditions are suitable.

Upon arrival, the mixture shall be dumped into the approved mechanical spreader, and immediately spread and struck off in a uniform layer to the full width required. The placed mixture shall be of such depth that when the work is completed, it will have the thickness shown on the Plans or as specified in the Contract and will conform to the grade and surface contour required. Machine methods of spreading and screeding are required unless otherwise permitted.

Should unevenness of texture, tearing, or shoving occur during the paving operation due to unsatisfactory material, methods, or equipment, the Contractor shall immediately take action to correct such unsatisfactory work.

The outside edges of the pavement shall be in true alignment, parallel to the centerline of the roadway. On Contracts requiring multiple lifts or courses, the width of the individual lifts shall be arranged such that the longitudinal joints of each successive lift are offset from the previous lift approximately 150 mm. The longitudinal joint in the surface course shall be at the lane line.

When placing adjacent lanes of the same course, pavers shall be equipped with a joint matching device which will automatically provide control of the depth of the mixture being placed so that, when compacted, it will match the depth of the adjacent lane.

The placement of roadway bituminous concrete shall be as continuous as possible. Intersections and irregular areas shall be paved after the adjacent roadway has been paved. Hand spreading with lutes will be permitted where irregularities or obstacles make the use of pavers impractical. The use of garden rakes will not be permitted.

No bituminous concrete shall be placed when the ambient air temperature at the location of the paving operation is below the temperatures indicated for the various types of bituminous concrete mixtures in the following table:

Table 401-A

Minimum Ambient Air Temperature for Placement of Types of Bituminous Material

Material Type	25-mm Lift or Less	26-mm to 50-mm Lift	Greater than 50-mm Lift
A	18 C	N/A	N/A
B	10 C	4 C	0 C
C	10 C	4 C	N/A
D	10 C	4 C	N/A
E	N/A	N/A	0 C

Note: Type A - Open graded plant mix wearing surface

Type B - Dense graded base and binder course

Type C - Dense graded surface course

Type D - Fine, dense graded surface course

Type E - Curb mix

No bituminous concrete shall be placed on any frozen surface or when, in the opinion of the Engineer, weather conditions, such as wind and low temperatures, prevent proper spreading, finishing, and compaction of the mixture. Subsequent lifts or courses shall not be placed over another lift or course placed on the same day while the temperature of the previously placed mix is 60 C or greater. Traffic shall be kept off the bituminous concrete until the mat temperature is less than 60 C.

The Contractor shall fill low places in the base with a leveling material consisting of hot-mix bituminous concrete base course or surface course material. The locations along the base course to receive this leveling course material, the type of material to be used, and the method to be employed in each case shall be as directed. Hot-mix bituminous concrete material shall be placed as directed around all manholes, drainage inlets, valves, or similar features when they are adjusted to the proposed grade. This material may be temporarily placed and shall be removed if directed.

After the hot-mix bituminous concrete base course is placed, it shall not lay exposed for a period longer than ten days. If, due to conditions of emergency, more than ten days elapse, a fog coat of RS-1 or CSS-l-h shall be sprayed uniformly on the exposed base course before placing the wearing course of hot-mix bituminous concrete. In addition, the Contractor shall plan the paving operation so that no bituminous base courses remain unsurfaced after the "winter shut-down" unless authorized by the Engineer.

The paving operation shall be conducted to minimize inconvenience to traffic and to protect existing and finished surfaces. Unless otherwise permitted, no single lane of any course shall be constructed to a length that cannot be completed to a full width of the pavement the following day. All hot-mix resurfacing operations shall be properly signed at the Contractor’s expense with notice of "Pavement Drop-Off" or "Uneven Pavement" in accordance with the approved traffic control plans.

At locations where the hot-mix is tapered to meet an existing roadway, a tack coat of bituminous material shall be uniformly applied on the tapered area at the rate of approximately 0.70 L/m^2.

401.09 Deep Lift Base Course. In addition to other tolerances specified in this Section, deep lift bituminous concrete base course shall be constructed in accordance with the following requirements:

(a) The base course shall be placed with an approved paver or spreader in approximately equal layers not exceeding 150 mm in depth after compaction.

(b) Base course placed in irregular shaped areas of pavement, such as transitions, turning lanes, crossovers, and entrances, may be placed in a single lift using a grader.

(c) Mix segregation will not be permitted regardless of method of placement. Should segregation occur, paving operations shall be stopped immediately and not resumed until the cause is determined and corrected.

401.10 Compaction. Immediately after the bituminous mixture has been spread and struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition, and when the rolling does not cause undue displacement, cracking, or shoving. Delays in rolling freshly spread mixtures will not be permitted. The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

The rollers shall be operated with the drive wheels positioned toward the paver, at speeds slow enough to avoid displacement of the mixture. Rolling shall start longitudinally at the sides, parallel to the centerline of the work, and progress towards the center, overlapping on successive trips by at least one-half the width of the roller. Alternate trips of the roller shall be of slightly different lengths. When paving in echelon or paving a lane which abuts a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves, the rolling shall begin at the low side and progress towards the high side by overlapping, longitudinal trips, parallel to the centerline. All roller marks shall be rolled out.

The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixtures. All displacement occurring as a result of the reversing of the direction of the roller, or from any other cause, shall be corrected to the satisfaction of the Engineer. To prevent adhesion of the mixture to the wheels of the roller, they shall be kept properly moistened, but excess water will not be permitted.

Along curb, headers, manholes, railroad crossings, and similar structures, and at all places not accessible to the roller, thorough compaction shall be obtained using approved tampers. At all contacts of this character the joints between these structures and the mixture shall be effectively sealed. All mixtures that become loose and broken, mixed with dirt, or in any way defective, shall be removed and replaced with fresh, hot mixture. The replacement mixture shall be immediately compacted to conform to the surrounding area. Areas showing an excess of asphalt cement, as determined by the Engineer, shall be removed and replaced.

401.11 Compaction Testing. Compaction shall be controlled by the following methods at the discretion of the Engineer:

(a) Bituminous mixtures shall be compacted to a degree of compaction of not less than 92% of the theoretical voidless density obtained by laboratory calculation for surface courses and not less than 90% of the theoretical voidless density obtained by laboratory calculation for base and binder courses. Laboratory compaction is the average density obtained by the Maximum Specific Gravity in accordance with AASHTO T 209 for the mixtures being produced and being placed. The degree of compaction shall be determined through measurement of actual pavement density using a nuclear density gauge in accordance with ASTM D 2950 and a laboratory compacted specimen density using the Maximum Specific Gravity and shall be expressed as a percentage:

(b) At the option of the Engineer, 100 mm diameter, diamond-bit drilled roadway cores shall be obtained from the constructed pavement mixtures for laboratory pavement density determination in lieu of the nuclear method.

(c) When theoretical voidless density values are not immediately available, or at the option of the Engineer, pavement compaction may be monitored by measuring the in-place density using a nuclear density gauge and comparing it to a control strip target density. The mean pavement compaction shall be at least 98% of the control strip target

density and sufficiently uniform that individual test results are at least 96% of the control strip target density. If any individual test result falls below 96% of target density, the mixture represented by the test will be considered defective and the Contractor shall further compact the sublot. After further compaction, the original test site and one other randomly selected site within the sublot will be tested. The average of the two test results will be included in the mean density for that day's production. The original test will not be included.

To determine the control strip target density, a control strip with a minimum length of 90 m shall be constructed at the beginning of work on each pavement course. Each control strip is to remain in place and become a section of the completed roadway. A control strip shall have an area of approximately 325 m^2 and shall be the same depth specified for the pavement course which it represents.

The materials used in the construction of the control strip shall conform to the requirements of the approved job mix formula. They shall be furnished from the same source and shall be of the same type used in the remainder of the pavement course represented by the control strip. The prepared base upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer. It shall be of the same type and weight to be used on the remainder of the pavement course represented by the control strip.

Compaction of the control strip shall commence as soon as possible after the mixture has been spread to the desired thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no appreciable increase in density can be obtained by additional roller passes.

Upon completion of the rolling, the mean density of the control strip will be determined by averaging the results of ten nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip shall be the target density for the remainder of the pavement course that it represents. Compaction shall be expressed as a percentage of the target density:

If the mean density of the control strip, as determined by cored samples taken in accordance with AASHTO T 230 Method B is less than 95% of the density of laboratory compacted specimens for surface mixtures, or 90% for base mixtures, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer if requested by the Contractor when:

(1) A change in job mix formula is made
(2) A change in the material from the same source is observed
(3) There is reason to believe that a control strip density is not representative of the bituminous mixture being placed.

If the densities are not obtained, additional rolling or the use of more approved rollers will be required. All roller marks shall be rolled out.

401.12 Joints. Placing of bituminous concrete shall be as nearly continuous as possible. The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint between old and new pavement or between successive days' work, the joint shall be made by placing a bulkhead or tapering the course. If the course is tapered, the edge shall be cut back to its full depth and width on a straight line to expose a vertical surface to remove the taper prior to placing the next section. It is not the intent of this Section to require an existing (old) pavement to be cut back full depth transversely when the paving work being performed

is an overlay tie-in unless such is designated in the Special Provisions or on the Plans. With either method, all contact surfaces shall be coated with an approved tack material before placing any fresh mixture against the joint.

Longitudinal joints shall be rolled directly behind the laying operations. The first lane shall be true to line and grade and have a vertical face. The material being placed in the abutting lane shall be tightly compacted against the vertical face of the previously placed lane. The finishing machine shall be positioned so that the spread material overlaps the edge of the lane previously placed by 25 to 50 mm, and is left sufficiently high to allow for compaction. Before rolling, the material overlapping the joint shall be carefully deposited adjacent to the joint of the unrolled lane with a lute. When the abutting lane is not placed the same day, or the joint is distorted by traffic or other means, the edge shall be carefully trimmed to line and coated uniformly with tack material. The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 150 mm. However, the joints in the completed surfacing shall be at the lane line.

401.13 Surface Requirements. After final rolling, the surface will be tested longitudinally and transversely by the Engineer using a 3.048-m rolling straightedge or straightedge at locations selected by the Engineer. The distance between the surface and the testing edge of the straightedge between any two contact points shall not exceed the following limits:

(a) For Base Courses:

(1) Lower courses: ±10 mm

(2) Top course: ±6 mm

(b) For Surface Courses:

Multiple and single course construction: ±6 mm

Areas found to exceed these tolerances shall be corrected, or removed and replaced by the Contractor, as directed, to conform to the required surface tolerances.

The Contractor shall have available at all times an approved 3.048-m straightedge for use by the Engineer.

401.14 Method of Measurement. The quantity of hot-mix, hot-laid bituminous concrete will be measured as the actual number of metric tons for hot-mix bituminous concrete placed and accepted. The weight shall be calculated as specified in Subsection 109.01.

Actual measurement of the quantity of tack coat applied will not be required.

401.15 Basis of Payment. The quantity of hot-mix, hot-laid bituminous concrete will be paid for at the Contract unit price per metric ton. Price and payment will constitute full compensation for furnishing, preparing, hauling, and placing all materials, including asphalt for tack coat; for removing hot-mix bituminous concrete from around manholes, drainage inlets, valves, and similar features; for removing and replacing excess asphalt cement, as determined by the Engineer; for applying a fog coat; and for all labor, equipment, tools, and incidentals required to complete the work, including the correction of defective work.

SECTION 402 HOT-MIX BITUMINOUS CONCRETE AND COLD-LAID BITUMINOUS CONCRETE FOR TEMPORARY ROADWAY MATERIAL (TRM)

402.01 Description. This work consists of furnishing and placing hot-mix bituminous concrete and cold-laid bituminous concrete as temporary roadway material (TRM) for the maintenance and repair of the roadway, for pipe and utility crossings, for driveways and entrances, for temporary ramps up to curbs, and for other areas as directed by the Engineer. TRM under this Section shall not be used for constructing detour roads or other temporary roadway; however, it can be used for their maintenance.

402.02 Materials. Materials for TRM shall conform to the following Sections:

Cold-Laid Bituminous Concrete - 815
Hot-Mix Bituminous Concrete - 823

402.03 Construction Methods. Repair of the existing pavement and the placement of TRM, hot or cold, shall be done as approved or directed by the Engineer. The work shall be coordinated with all other work and operations necessary to maintain traffic.

402.04 Method of Measurement. The quantity of hot-mix bituminous concrete and cold-laid bituminous concrete for TRM will be measured as the actual number of metric tons for each type of bituminous mixture placed and accepted.

402.05 Basis of Payment. The quantity of hot-mix bituminous concrete and the quantity of cold-laid bituminous concrete will be paid for at the respective Contract unit prices per metric ton. Price and payment will constitute full compensation for furnishing, preparing, hauling, placing, and compacting all materials and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 403 PLANT MIX OPEN-GRADED WEARING SURFACE

403.01 Description. This work consists of furnishing all materials for and constructing an open-graded wearing surface.

403.02 Materials. Materials for open-graded wearing surfaces shall conform to the requirements of Section 823. An approved heat-stable, anti-stripping agent shall be added to all asphalt cement used for open-graded wearing surfaces.

EQUIPMENT

403.03 Hauling Equipment. All requirements of Subsection 401.04 shall apply.

403.04 Pavers. All requirements of Subsection 401.05 shall apply.

403.05 Rollers. Rollers shall be in good condition and be capable of reversing without blacklash. The use of equipment that results in crushing of the aggregate will not be permitted. Rollers shall be steel-wheeled capable of exerting a load of not less than 4.5 kg/mm of width of compression roll or rolls. Rubber tired rollers will not be permitted on the open-graded wearing surface.

CONSTRUCTION METHODS

403.06 Placement. The pavement shall be constructed in conformance with the requirements of all applicable Subsections of Section 401.

The mix shall be spread and struck-off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width of the roadway or over such partial width as may be practicable. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread and luted by hand tools.

No open-graded wearing surface shall be placed when the ambient temperature is below 18 C.

403.07 Compaction. After the bituminous mixture has been spread and struck off, and the surface irregularities adjusted, the mixture shall be thoroughly and uniformly compacted by rolling. The bituminous mixture shall be rolled in a longitudinal direction, commencing at the outside edge of the roadway and progressing towards the center. Rolling shall be accomplished with a steel-wheeled roller or rollers, conducted in such a manner that shoving, distortion, or stripping will not develop beneath the roller. On superelevated curves, the rolling shall commence on the low side and progress to the high side. The amount of rolling shall be limited to only that necessary for consolidating the bituminous mixture and bonding it to the underlying surface. Excessive rolling shall be avoided.
The completed bituminous mixture shall be protected from all traffic until it has cooled sufficiently to resist distortion, abrasion, or pickup.

The Contractor is advised that early breakdown is essential due to rapid temperature loss of the open-graded mix. It is anticipated that two complete passes of the roller will provide adequate compaction. Density tests on the open-graded wearing surface will not be conducted. The Contractor will be directed to cease rolling when, in the opinion of the Engineer, maximum density has been achieved. Determination will be by visual means. Over-rolling will result in aggregate fracture, which shall be avoided.

403.08 Joints, Trimming Edges, and Cleanup. Placing of the bituminous mixture shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back the previous run to expose the full depth of the course. A tack coat shall be used on the contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

The exposed edges of the completed mat shall be cut off true to the required lines. Material trimmed from the edge, and all other discarded bituminous mixture, shall be removed from the roadway and disposed of by the Contractor.

403.09 Finished Work Samples. The Engineer may cut samples from the pavement for testing. Samples will be neatly cut by a saw or core drill. The Contractor shall supply and place new material to backfill voids left by sampling.

403.10 Method of Measurement. The quantity of bituminous plant mix open-graded wearing surface will be measured as the actual number of metric tons for bituminous plant mix open-graded wearing surface placed and accepted. The weight will be determined according to Subsection 109.01.

403.11 Basis of Payment. The quantity of bituminous plant mix open-graded wearing surface will be paid for at the Contract unit price per metric ton. Price and payment will constitute full compensation for furnishing, preparing, hauling, and placing all materials, including anti-stripping agent; for furnishing and placing materials in voids left by sampling; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 404 BITUMINOUS SURFACE TREATMENT

404.01 Description. This work consists of constructing one or more courses of bituminous material and aggregate upon the completed and accepted foundation or existing surfacing.

MATERIALS

404.02 Asphalt. The asphalt for bituminous surface treatment shall be RC-70 or CRS-1 for the prime coat and RC-250 or CRS-2 for seal coats. All material shall conform to the requirements of Section 811 or 817 whichever is applicable. The material used shall be applied within the following temperature limits:

Material	Limits (C)
RC-70	27 to 66
RC-250	38 to 79
CRS-1	21 to 60
CRS-2	52 to 85

404.03 Coarse Aggregate. Coarse aggregate shall conform to the following requirements:

(a) Coarse aggregate for the initial treatment may consist of crushed slag composed of clean, tough, durable pieces of air-cooled blast-furnace slag, reasonably uniform in density and quality, and free of glassy particles, coke, dirt, or other objectionable matter.

(b) Crushed slag in dry condition shall weigh not less than 1120 kg/m^3 when tested according to AASHTO T 19/T 19M, Rodded Method.

(c) Coarse aggregate for initial treatment may also be crushed stone or crushed gravel weighing not less than 1520 kg/m^3 when tested according to AASHTO T 19/T 19M and conforming to the requirements of Section 805.

(d) The slag, crushed stone, or crushed gravel shall conform to the grading requirements of Section 813, Delaware No. 57 or 67.

(e) Coarse aggregate for the two treatments following the initial application shall consist of crushed chips composed of crushed stone, crushed gravel, or crushed slag, conforming to the requirements of Section 813, Delaware No. 8.

404.04 Fine Aggregate. Sand for tack coat shall conform to the requirements of Section 804.

EQUIPMENT

404.05 Distributors. The distributors used shall be capable of uniformly applying the bituminous material in liquid form. Devices to control the pressure, volume, and temperature shall be provided. Each distributor shall have an approved calibration chart, be equipped with an approved sampling device, and conform to the following:

(a) *Pressure.* The pressure shall be supplied by a positive displacement pump or air compressor. The pressure shall be uniform throughout the entire width of spray. If pressure is supplied by an air compressor, automatic controls must be provided to maintain sufficient and even pressure throughout the application of an entire load.
(b) *Temperature.* The distributor shall be equipped with a heating system that applies heat uniformly across the width of the tank. Provisions shall be made for circulating or agitating the material whenever necessary while heating. The distributor shall be equipped with a thermometer marked in degrees Celsius of sufficient range to determine the actual temperature of the material.
(c) *Tachometer.* All distributors shall be provided with an approved tachometer recording meters per minute with a tabulation of meters per load with adjustments. Each load tabulation shall start at zero. There shall also be a totaling tabulation of this instrument.
(d) *Volume.* A tachometer shall give correct readings of the speed, and the volumetric efficiency of the distributor shall ensure the correct volume at various speeds. Tests shall be required to prove the volumetric efficiency of the distributor at various speeds as directed by the Engineer.
(e) *Circulating System.* All pump distributors shall be equipped with a circulating system designed to maintain a homogenous liquid while circulating in the distributor tank. This circulating system shall also be arranged to circulate the material in the tank truck before application.
Air distributors shall be equipped with a device for agitating the bituminous material in the tank trucks when necessary.
(f) *Tests.* Necessary tests shall be made to determine the accuracy of all pressure gauges, tachometers, and pump efficiencies. The tests shall be made by the Contractor when and as required.
(g) *Spray Bars.* Each distributor shall be equipped with spray bars capable of applying material uniformly throughout the entire length of the spray bars when they are extended. Spray bar extensions shall be provided for applying up to a 7.3-m width in one operation. Spray bars shall be equipped with a cleaning device and a shut-off valve to prevent dribbling, dripping, or streaking.
(h) *Tank Capacity Gauge.* A float or other approved type tank capacity gauge shall be furnished to indicate the volume in the tank in not less than 500-L units. The gauge shall have adjustments for correction.
Tanks shall have a minimum capacity of 2800 L.
If the Engineer deems that the equipment applying the material is inadequate or fails to comply with all regulations, the Engineer will order the equipment to be removed from the job and require that another unit be placed on the work.

404.06 Mechanical Spreader. The Contractor shall furnish and operate at least one approved mechanical spreader capable of receiving the material to be spread and being accurately adjusted to distribute the aggregate uniformly at a regulated truck speed.

404.07 Broom Drag. A broom drag shall be furnished and used on the initial application of coarse aggregate. The broom drag shall be a non-revolving type, at least 4.5-m in length, and shall have at least four rows of brooms. One row must be at each end of the drag.

404.08 Rollers. The Contractor shall furnish and operate at least two power rollers. One power roller shall be three-wheeled, rated by the manufacturer to be between 4500 and 7300-kg. The other power roller shall be a self-propelled, pneumatic-tired roller of approved design and weight, unless otherwise directed.
The tires of the rubber tire roller shall be uniformly inflated. The difference between the pressure in any two tires shall never be greater than 35 kPa. The Contractor shall provide means for checking the tire pressure on the job at all times.

CONSTRUCTION METHODS

404.09 Seasonal and Weather Limitations. Surface treatment shall not be applied during the following conditions:

(a) on any wet or frozen surface,
(b) when the ambient temperature is below 10 C,
(c) between October 1 and April 15, without written permission from the Engineer, and
(d) when the weather conditions prevent the proper completion of the work, as determined by the Engineer.

404.10 Application. The bituminous surface treatment shall be completed according to the following procedure.
The first application of bituminous material shall not be applied until the moisture content of the foundation is within 2% of the optimum moisture content and the roadway has been properly shaped and approved. An initial application of priming asphalt shall be applied at the rate of approximately 2.3 L/m^2. Then, approximately 27 kg/m^2 of stone or 22 kg/m^2 of slag shall be spread from a mechanical spreader. After the initial treatment, two treatments shall be applied using approximately 1.4 L/m^2 of sealing asphalt and from 9 to 11 kg/m^2 of crushed chips for each application. If slag is used, approximately 1.6 L/m^2 of sealing asphalt shall be used for each treatment.

404.11 Heating and Application of Bituminous Material. Bituminous materials used for each treatment shall be heated in a manner that ensures even heating of the entire mass and maintained within the specified temperature and pressure range during application. Any material that has been damaged shall be rejected, and any section treated with damaged material shall be removed and replaced.

The bituminous material shall be applied in one application at the rates specified using the pressure distributor for the full width of the treatment, unless otherwise directed.
The nozzles of the spray bar shall be kept clean at all times. If one or more nozzles become blocked during the application of bituminous materials, the distributor shall be stopped immediately, and the nozzles shall be cleaned. The streaked areas shall be made uniform using a hand hose or other approved methods.

Joints shall be made by an approved method that ensures proper seal with the preceding application. All excess bituminous material at the transverse junction between distributor loads shall be removed and corrected in a satisfactory manner.

If the Contractor is unable to keep the application uniform, the operation shall be discontinued until a more experienced operator or a better distributor, or both, can be provided; or, the Contractor shall take such other precautions as may be necessary to keep the application within specified limits.

When applying bituminous materials adjacent to structures or curbs, the Contractor shall furnish and use effective means of protecting the structures or curbs from discoloration.

404.12 Spreading of Coarse Aggregate. As soon as the bituminous material has been applied, it shall be uniformly covered with the specified amount of coarse aggregate. The aggregates shall be applied immediately after the application of the bituminous material for prime and seal coats.

Spreading shall be done directly from trucks using approved mechanical spreaders. Trucks or spreaders shall not drive on the uncovered bituminous material.

During the spreading of coarse aggregate, a crew equipped with hand brooms shall broom all areas where the aggregate has been unevenly applied. Additional aggregate shall be placed by hand on all areas not properly covered. If directed, the surface shall then be dragged with a light broom drag until a smooth and even surface is obtained.

404.13 Rolling of Coarse Aggregate. Immediately after brooming and dragging, the coarse aggregate shall be rolled in a longitudinal direction with an approved pneumatic-tired roller or rollers. The rolling shall begin at the outer edges of the treatment and progress toward the center, each pass overlapping the previous pass by one-half the width of the roller. This rolling shall be continuous. Enough rollers will be required to complete the rolling operation within one hour after the application of the asphalt. The rolling shall be repeated as often as required to ensure thorough keying of the coarse aggregate into the bituminous material.

404.14 Application of Sand. Sand shall be applied to asphalt tack coats at the rate of approximately 5.4 kg/m^2 by means of approved mechanical spreaders or as directed.

404.15 Opening to Traffic. The roadway shall not be opened to traffic after the application of the treatments until bituminous materials have set and the coarse aggregate has embedded sufficiently to prevent picking up or whipping off by traffic.

Signs, barricades, lights, and necessary incidentals for detouring traffic shall be furnished and maintained by the Contractor.

404.16 Method of Measurement. The quantity of bituminous asphalt material will be measured as the number of liters applied through calibrated distributors. To determine the number of liters applied to the road at the application temperature, the volume of bituminous material in the distributor tank shall be measured while the distributor tank is on a level surface immediately prior to application and immediately following distribution using a rod graduated in 500 L increments.

The actual number of liters distributed, corrected to the corresponding volume at 16 C, shall be determined using conversion tables and shall be noted on the tickets.

The quantity of coarse aggregate will be measured as the number of metric tons placed and accepted. The weight of each load will be determined according to Subsection 109.01.

404.17 Basis of Payment. The quantity of bituminous asphalt material will be paid for at the Contract unit price per liter. The quantity of coarse aggregate will be paid for at the Contract unit price per metric ton. Price and payment will constitute full compensation for furnishing and storing all materials; for applying bituminous surface treatment materials and spreading, broom dragging, and rolling coarse aggregate; for removal and replacement due to damaged bituminous asphalt and aggregate material; for controlling traffic; and for all labor, equipment, tools, and incidentals required to complete the work.

Any demurrage or loss of time caused by inadequate or non-compliant equipment will be at the Contractor's expense. Sand will be paid for under Section 756.

SECTION 405 BITUMINOUS SURFACE RETREATMENT

405.01 Description. This work consists of one or more applications of bituminous material followed by one or more applications of cover aggregate applied to a surface.

405.02 Materials. Materials shall conform to the requirements of Subsections 404.02 and 404.03.

405.03 Construction Methods. All provisions of Section 404 shall govern except as follows:

(a) The Contractor shall furnish all equipment, tools, labor, and incidentals required to prepare the traveled way so that it will be free from deposits of dirt, loose stone, or other objectionable material before applying the bituminous material. Each surface or section of the traveled way must be approved before applying the bituminous material.
(b) Prime coats shall be omitted.
(c) The bituminous material application rate may be varied as directed.
(d) The covering aggregate shall be applied at approximately 9 kg/m^2, but may be varied as directed.

405.04 Method of Measurement. The quantity of retreatment and seal coats will be measured according to Subsection 404.16.

405.05 Basis of Payment. The quantity of retreatment and seal coats will be paid for according to Subsection 404.17.

SECTION 406 HOT-MIX PATCHING

406.01 Description. This work consists of hot-mix patching Portland cement and bituminous concrete pavement.

406.02 Materials. Hot-mix bituminous patching material shall conform to the requirements of Section 823.
Graded aggregate base course shall conform to the requirements of Subsection 302.02.

406.03 Construction Methods. Construction methods shall conform to the applicable Subsections of Sections 401 and 302.

The pavement shall be sawed before patching using a concrete cutting machine mounted on a sturdy frame equipped with control devices and a suitable-motor driven-diamond blade circular cutter. The equipment shall be capable of cutting a groove in a straight line to a sufficient depth so that an even, neat joint is cut to allow removal of material without

damage to adjacent paving. Water shall be continuously supplied to the cutting element either by a water tank on the equipment or other means.

If the pavement is other than Portland cement concrete, the equipment for cutting shall be of a type approved by the Engineer.

406.04 Method of Measurement. The quantity of hot-mix patching will be measured as the actual number of square meters of patching per thickness specified, placed and accepted. The width will be measured from outside of the completed patches as constructed. The length will be the actual length measured along the centerline of pavement.

406.05 Basis of Payment. The quantity of hot-mix patching will be paid for at the Contract unit price per square meter per thickness specified. Price and payment will constitute full compensation for removal and disposal of existing materials, for preparing the subgrade, and for all labor, equipment, tools, and incidentals required to complete the work.
Furnishing, hauling, and placing hot-mix bituminous concrete pavement and graded aggregate base course will be paid for under Sections 401 and 302 respectively.

Excavation of unsuitable material will be paid for under Section 212.

Payment for sawing and removing Portland cement concrete pavement will be made in accordance with Sections 762 and 758 respectively unless otherwise required by the Plans or Special Provisions.