DIVISION 500 RIGID PAVEMENT

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SECTION 501 PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This work consists of constructing a jointed, Portland cement concrete pavement on a prepared base using either fixed forms or slip forms.

When requested by the Contractor and approved by the Engineer, use of the slip-form method for Portland cement concrete pavement construction will be permitted. However, when unsatisfactory performance characteristics as described in this Section warrant, the slip-form method of construction shall be discontinued.

The Engineer will evaluate the smoothness of the riding surface by using either a rolling straightedge, a straightedge, or a California-type profilograph.

501.02 Materials. Materials for Portland cement concrete pavement shall conform to the following Section and Subsections:

Materials for Sealing Joints:

- Hot-Poured Joint Sealant
- Preformed Elastomeric Compression Seals
- Low-Modulus Silicone Sealant

Curing Materials:

- Liquid Membrane Compounds
- Polyethylene Sheeting
- Waterproof Paper
- Concrete Mix Composition, Class B, Fixed-Form Paving
- Concrete Mix Composition, Class B, Slip-Form Paving

Embedded Hardware:

- Tie Bars
- Coated Dowel Bars
- Load Transfer Assemblies
- Tie Bolts (including hook bolts and W-bolts)

Samples of fine aggregate, coarse aggregate, and cement shall be submitted to the Department at least 60 calendar days before any paving operations begin so that trial mixes may be made by the Department to determine the water-cement ratio and the proportions of fine and coarse aggregate.

CONSTRUCTION METHODS FOR FIXED-FORM PAVING

501.03 Preparation of the Base Course. The base course shall be shaped, rolled, uniformly compacted, and brought to a firm, unyielding surface as specified under the appropriate Section in Division 300 or 400. The foundation shall conform to the lines and grades including 600-mm extension outside each edge of the proposed pavement, or as shown on the Plans, before any concrete forms are placed. Any portion inaccessible to the roller shall be compacted thoroughly with hand tampers weighing not less than 22 kg, having a bearing or tamping face that does not exceed 65 000 mm^2 in area. All unsuitable, soft, and yielding material which will not compact readily, shall be removed and backfilled with suitable material, and the grade shall be recompacted until no depressions develop. Should sufficient time elapse between the

rough grading and the laying of the pavement to allow the foundation to become baked and hardened, whether traffic has been allowed on the grade or not, the surface shall be dampened, rescarified, and recompacted, if directed.
In preparing the foundation, the material excavated shall not be piled outside and along the line of the forms in such a manner as to interfere with the proper operation of finishing tools or machinery.

Ditches and drains shall be provided to drain the foundation. Pavement shall not be placed on frozen material. Frost crystals or mud caused by freezing and thawing shall be removed and replaced with suitable material before placing any pavement on the foundation.

The grade shall be in final condition for the placement of pavement for a distance of at least 30-m before any paving may begin. No trucks transporting proportioned aggregates, mixed concrete, or other materials shall be permitted on the grade, unless otherwise directed.

Before any concrete may be placed, the Contractor shall check each section of the grade with an approved grade tester, mounted on rollers, wheels, or tracks, and designed to move backwards and forwards. The grade tester shall be adjustable vertically and constructed so that the points may be set not more than 3 mm above the required grade elevation. The 3-mm tolerance provided in the grade tester shall in no way be construed as permitting less than the full thickness of pavement as specified on the Plans. Measurement by string line or other methods may be employed if deemed necessary. When marks or indentations are made by the tester, the grade shall be lowered to the required depth and the tester again passed over the grade until all high spots are removed. The grade tester must be in place on the forms immediately in advance of the point where the concrete is placed. No loose earth shall be placed on the portion of the grade that lies between the grade tester and the newly deposited concrete.

501.04 Temperature Requirements for Concrete Placement. The following requirements shall govern the placing of concrete during cold and hot weather, however, the Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions:

(a) Concrete may be placed when the air temperature in the shade and away from artificial heat is at least 2 C and rising.

(b) The concrete shall have a temperature of 21 ± 11 C at the time of placement unless prior permission has been granted to exceed these tolerances.

(c) When concrete is being placed during cold weather and the air temperature may be expected to drop below 2 C, a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the line of work. When the temperature may be expected to reach the freezing point, 0 C during the day or night, the material so provided shall be spread over the pavement including the vertical face of the sides and/or end of the concrete to a sufficient depth to prevent freezing of the concrete. The insulating material shall be adequately secured to hold it in place on the pavement and the material shall meet the requirements of Subsection 602.11 (c). This protection shall be maintained for not less than five days. A longer period may be required if directed by the Engineer. The Contractor shall be responsible for the quality and strength of the concrete laid during cold weather. Any concrete injured by frost or freezing action shall be removed and replaced.

(d) In hot weather, when the temperature of the plastic concrete reaches 29 C at the mixing plant, particular attention shall be given to the sprinkling and wetting of the foundation and forms, the placing and finishing operations, and the prompt starting of the curing operation.

(e) Concrete shall not be placed when its temperature exceeds 32 C in the plastic state after mixing.

501.05 Construction Equipment. The Contractor shall furnish and maintain all equipment necessary to complete the work. The equipment shall be at the Project site sufficiently ahead of the start of construction operations to be thoroughly examined and approved. The Contractor shall, no later than 15 calendar days prior to paving, supply the Engineer with the manufacturer’s specifications for each piece of equipment the Contractor intends to use.
The concrete shall be placed, spread, consolidated, screeded, and finished by approved equipment in such a manner that a minimum of hand finishing will be necessary to produce a dense and homogeneous pavement in conformance with the Plans and Specifications.

The finishing machine shall be power driven, designed and operated to strike-off, screed, and consolidate the concrete as it travels. It shall be of ample weight and strength to furnish pressure and withstand the requirements of the construction.

The finishing machine shall be capable of being adjusted to produce the crown, width, and finish required. It shall have sufficient power and be geared to operate consistently and smoothly. All finishing machines shall be maintained in first class working order at all times. Each machine shall be equipped with two screeds and at least one pair of extra shoes for each screed. Worn shoes shall be removed and replaced.

Vibrators providing full-width vibration of concrete paving slabs may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, grade, or side forms. The frequency of the surface vibrators shall not be less than 3500 impulses per minute. The frequency of the internal type vibrator shall not be less than 5000 impulses per minute for tube vibrators and not less than 7000 impulses per minute for spud vibrators. When either hand-operated spud type internal vibrators, or spud-type internal vibrators attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3500 impulses per minute. Contractor shall provide impulse calibrator for verification of vibrators impulses at all times. Where the existing pavement is used to support the finishing machine in lieu of a form, the wheels of finishing machines shall be adjusted to provide full bearing on the pavement and extended to prevent breaking the pavement edge.

501.06 Forms and Form Setting. Side forms shall be metal of approved design and cross-section, of depth equal to, or not more than 25 mm in excess of, the designed edge thickness of the pavement. Side forms shall have no horizontal joints. The forms shall be in lengths of not less than 3 m except on curves of 45 m radius or less, in which case 1.5 m lengths may be used. Flexible or curved forms of proper radius shall be used for curves of 30-m radius or less.
The sections shall be connected so that the joint connection has no play or movement in any direction. The forms shall be of an approved section with a base width equal to the depth of the form. The forms shall be secured to resist, without spring or settlement, the pressure of the concrete when placed and the impact and vibration of the spreading or finishing machine. The forms shall be straight and free from warp. The top surface of any section shall be at the final grade and shall not deviate from a straight line by more than 3 mm.

The grade under the forms shall be hard and true so that the form set upon it will be firmly in contact for its whole length and at the desired grade. All foundation that, at the form line, is found to be below established grade shall be filled to grade for a distance of 600 mm on each side of the base of the form and thoroughly rerolled or tamped. Imperfections and variations above grade shall be corrected by tamping or by cutting as necessary. No settlement or springing of forms under the spreading or finishing machine will be permitted.

Forms shall be accurately set to line and grade, joined, and staked by using no less than three 22-mm diameter pins 750 mm long for each 3-m section. Shorter pins may be allowed for use if a 750-mm length is found to be impractical. Conformity of the alignment and grade elevation of forms with the alignment and grade elevation shown on the Plans shall be checked and, if necessary, corrections shall be made by the Contractor immediately prior to placing the concrete. Where any form has been disturbed, or any foundation become unstable, the form shall be reset and rechecked after restoring the required grade.

Where alignment permits, forms shall be set at least 250 m in advance of the point where concrete is being placed and shall remain in place at least 12 hours after the concrete has been placed against them. The forms shall be cleaned and oiled each time they are used.

501.07 Placing Concrete. The grade shall be in a moist, but not muddy, condition at the time of placing the concrete. If required, the grade shall be thoroughly wetted with an approved sprinkling device. If the grade subsequently becomes dry, the foundation shall be sprinkled.

No concrete shall be placed adjacent to railway tracks, or around manholes, inlets, or other structures until they have been brought to the required grade and alignment. All structures that project through the pavement shall be cleaned thoroughly to permit adhesion of the concrete.

The concrete shall be placed by approved methods so that the batches will be deposited without segregation, and will be uniformly distributed and spread over the entire width of the required pavement section using a mechanical spreader. The mechanical spreader shall be self-propelled, capable of spreading the concrete mix to the desired cross-sections, and easily adjustable to spread different elevations of concrete.

The concrete shall be deposited on the grade from agitator truck chutes without segregation or from non-agitating hauling equipment with means for discharge, without segregation, through a hopper on the spreader, moving hopper or belt, or other approved conveyance. Non-agitating equipment may not be used with fixed-form paving, unless approved by the Engineer. The concrete shall be placed in horizontal layers with each successive batch placed against previously placed concrete. Spreading shall be accomplished with the mechanical spreader. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with hand shovels,

not rakes. Workers shall not walk in the freshly mixed concrete with boots or shoes that are coated with earth or foreign substances.

When concrete is to be placed adjoining a previously constructed lane of pavement by mechanical equipment that is to be operated upon the previously constructed lane of pavement, then the previously constructed lane of pavement shall have attained a minimum compressive strength of 20 MPa as determined by representative cylinders. If only finishing equipment is operated on the edge of the previously constructed lane, paving in adjoining lanes may be permitted after the concrete in the previously constructed lane achieves a minimum compressive strength of 15 MPa.
Concrete shall be thoroughly consolidated against and along the faces of all forms, and along the full length and on both sides of all joint assemblies, using vibrators. Vibrators will not be permitted to come in contact with a joint assembly, the grade, or the side form. In no case shall the vibrator be operated longer than ten seconds in any one location.
Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing the joints, but shall not be dumped from the discharge bucket, chute, or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any foreign matter or substances fall on or be worked into the surface of a completed slab, such materials shall be removed immediately by approved methods.

501.08 Consolidating and Screeding Concrete. Following the placement of concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the Plans. As soon as the concrete has been spread, it shall be leveled and struck off with a finishing machine to such elevation above the finished grade that when properly consolidated, the surface shall conform to the lines and grades shown on the Plans.

Segregated particles of coarse aggregate which collect in front of the screeds shall be either thrown outside the forms or thoroughly mixed by hand with the mass of concrete already on the grade. Under no circumstances shall segregated particles be carried forward by the finishing machine and pushed into the grade in front of the concrete. Care shall be exercised to control the operation of the machine to prevent excess mortar and water from being worked to the top. The number of operations of the machine over a given area shall be held to the minimum necessary to secure the required strike-off. While the concrete is being struck off, a sufficient number of workers shall be leveling, spading along forms, and shaping the concrete ahead of the machine.

Where it is necessary to complete variable width pavement at a width of less than 3 m or where the full design width of pavement is less than 3.6 m, a mechanical concrete spreader and finishing machine will not be required, and the concrete may then be struck off and consolidated using an approved vibrating screed and hand operated spud vibrators. The vibrating screed for the surface shall be at least 600 mm longer than the maximum width of the slab to be struck off. It shall be of approved design and sufficiently rigid to retain its shape. The screed shall be constructed either of metal or of other suitable material shod with metal.

During the striking off process, the vibrating screed shall be moved forward on the forms, always moving in the direction that the work is progressing and manipulated so that neither end is raised from the side forms. If necessary, the striking off process shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

501.09 Finishing. After screeding, all laitance, surplus water, and inert material shall be worked entirely off the pavement, and the surface shall be made smooth by scraping or dragging with an approved rigid straightedge having a length of 3.048 m.

The straightedge shall be placed at the inner edge of the slab with the blade parallel to the centerline and pulled slowly and uniformly to the edge. This operation shall be repeated until the surface of the concrete is free from irregularities and makes contact at all points with the bottom of the straightedge. The straightedge shall then be moved forward one-half of its length and the process repeated.

Depressions found in the surface shall be filled with fresh concrete and consolidated by floating with a long handled float not less than 900 mm in length. This float may also be used to smooth sections of the surface that may have become rough or torn by scraping with the straightedge.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray using approved spray equipment.

Directly after fog spraying, the straightedge shall be used in a similar manner a second time. However, at this time the smoothness of the surface will be checked, and no more scraping than is absolutely necessary will be done. During this process, the contact of the straightedge with the concrete shall be uniform over the entire length tested. At the time of this final checking, the surface shall be free from soft mortar and excess water. No floating operation will be permitted following the final straightedge.

All the edges of the new pavement shall be tooled with approved edging tools as specified. The work of tooling the edges shall be done in an acceptable manner. All tooled edges and faces shall be smooth with no irregularities, bumps, or depressions remaining in the concrete after the tooling operation is completed. The edges shall be perfectly shaped to the radius of the edging tools. The outside edge of the face of the edging tools shall not gouge irregular depressions in the surface of the pavement. On all joints, the tools shall be guided in such a manner that the full width of the face of the tool will make a uniform depression in the surface of the pavement. This depression shall not exceed 1.6 mm, and it shall extend the full length of all joints. All corners, including the intersections of longitudinal joints with transverse joints, shall be molded and tooled into true corners. The concrete shall be sound and homogeneous in all cases.

When the straightedge and edge tooling operations have been successfully accomplished and all excess moisture has disappeared, the plastic concrete shall be textured transversely for the full width of the pavement using a mechanized texturing device. The texturing device shall ride on forms or be guided electronically by stringline and shall utilize use a wire comb consisting of 2.5 mm wide flat steel tines, 125 to 150 mm long, with a 13 mm spacing between tines. The tines shall form rectangular shaped grooves approximately 2.5 to 5 mm in width and approximately 5 mm, but not less than 3 mm, in depth. The wire comb shall meet the approval of the Engineer. The texture shall be produced by drawing the approved comb across the pavement in a transverse direction in one pass without tearing or dragging the mortar. The concrete shall be dry enough to prevent the plastic concrete from flowing back into the grooves being formed. The method used shall produce a uniform finish. The texturing device shall be kept free of hardened concrete particles. Hand brooms approximately 1.2 m wide and made of wire comb, as specified above, shall be made available by the Contractor for use where mechanical tining cannot be performed.

501.10 Curing of Concrete. As soon as possible after the texturing operations and without marring the surface, the freshly laid concrete shall be covered with polyethylene sheeting or waterproof paper, or sprayed with membrane curing compound.

As soon as the forms are removed, all honeycombed areas shall be repaired by filling with 1:2 mortar (one part cement to two parts sand) and the ends of the transverse joints shall be opened and cleaned to full depth. After all honeycombed areas have been repaired and all transverse joints have been opened and cleaned, the edges of the pavement shall be properly cured as described in Subsection 501.11, 501.12, or 501.13.

501.11 Curing with Liquid Membrane Compounds. Application of the material shall be made immediately following final finishing or texturing before any dehydration of the concrete or checking of the surface.

The curing compound shall be applied to the finished surfaces by means of an approved automatic spraying machine. The spraying machine shall be self-propelled and shall ride on the side forms or on previously constructed pavement, straddling the newly paved lanes. The machine shall be equipped with one or more spraying nozzles that can be controlled and operated to completely and uniformly cover the pavement surface with the required amount of curing compound. The curing compound being used for the spraying operation shall be thoroughly and continuously agitated in its storage drum during the application. Spray pressure shall be sufficient to produce a fine spray and cover the surface thoroughly and completely with a uniform film. The spray nozzle shall be provided with an adequate wind guard. The curing compound shall be applied with an overlapping coverage that will give a two-coat application at a coverage of not more than 5 m^2/L for each coat.

The application of curing compound by hand operated pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms, as authorized by the Engineer. When application is made by hand operated sprayers, the second coat shall be applied at right angles to the direction of the first coat. The compound shall form a uniform, continuous, coherent film, free from pinholes and other imperfections, that shall not check, crack, or peel. If pinholes or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes.

Concrete surfaces that are subjected to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method and at the coverage rates specified above. Necessary precautions shall be taken to ensure that none of the curing compound enters joints that are to be sealed. Rope of moistened paper, fiber, or other suitable material shall be used to seal the top of the joint opening. The concrete in the region of the joint shall be sprayed with curing compound immediately after the rope seal is installed. Other methods of protecting the joints may be used when approved by the Engineer.

Approved standby equipment or approved alternate methods for curing the concrete pavement shall be provided at a readily accessible location at the site of the work. The standby equipment or other method shall be used in event of mechanical failure of the spraying equipment or any other condition that may prevent correct application of the membrane-curing compound at the proper time. In the event of a failure of the regular spraying equipment, the paving operation shall be suspended and the standby equipment or alternate curing method shall be used only on the remaining portion of the paving already placed.

Concrete surfaces to which membrane curing compounds have been applied shall be adequately protected for the entire curing period from pedestrian and vehicular traffic, except as required for joint sawing operations and surface tests, and from any other cause which will disrupt the continuity of the membrane. The curing compound seal shall be given utmost protection for a minimum of five days so that it will not be broken. If the curing compound is damaged by subsequent construction operations within the curing period, the area shall be resprayed.

501.12 Curing with Polyethylene Sheeting. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The sheeting units used shall be lapped at least 450 mm. The sheeting shall be placed and weighted such that it will remain in close contact with the surface covered. The sheeting shall extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for five days after the concrete has been placed, except for the limited removal necessary for joint sawing. Immediately following joint sawing, the polyethylene shall be replaced and maintained in place for the remaining specified curing duration.

501.13 Curing with Waterproof Paper. Each waterproof paper cover shall be not less than 6 m, and not more than 23 m in length and shall be of such width that, when in place, it will extend at least 450 mm beyond the edges of the slab to be covered. Covers may be furnished in widths corresponding to that of the slab, provided that supplemental stringer sheets, at least 450 mm wide, are used. Such stringer sheets shall be placed along the edges of the slab under the covers. Covers not manufactured in sizes that provide the proper width shall be securely sewed or cemented together with minimum laps of 100 mm to produce an air-tight, waterproof joint that will not open or separate during the curing period. The covers shall be unrolled from suitable poles or spools, and placed in such a manner that the surface of the concrete will not be marred. The covers shall be securely held in place along the edges of the pavement with banks of earth placed just inside the form. When placed, the adjoining covers shall overlap transversely at least 300 mm, and the lap shall be securely weighted to form a sealed joint. Additional mounds of earth shall be placed at random on the covers as necessary to keep the covers in close contact with the surface of the pavement.

Upon removal of the forms, the excess width of the cover or the supplemental stringer sheets shall be pulled over the edges and carried down to the bottom of the pavement and promptly secured with a continuous bank of earth. When the pavement to be cured is adjacent to a previously constructed slab, the cover shall be lapped over the pavement already in place and securely held in position by a bank of earth or other suitable weight to provide a continuous sealed joint. Unless otherwise specified, the covering shall be maintained in place for five days after the concrete has been placed, except for the limited removal necessary for joint sawing. Immediately following joint sawing, the waterproof paper shall be replaced and maintained in place for the remaining specified curing duration.

In the event that hair-checking develops before the cover can be applied, curing with polyethylene sheeting or waterproof paper will not be permitted. Such hair-checked areas shall be protected with wet burlap.
All rips or holes occurring in the covers while in use shall be immediately repaired with a sealed patch to render them airtight. Covers that have become damaged or soiled to the extent that they will not provide satisfactory curing, or will mar the concrete, shall not be used.

501.14 Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 50 mm and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the pavement surface of the pavement. When rain appears imminent, all paving operations shall stop, and all available personnel shall begin placing forms against the exposed sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

501.15 Protection of Concrete. The Contractor shall erect and maintain suitable barricades and employ watchpersons, if required, to exclude traffic from the newly constructed pavement for the period herein prescribed. These barriers shall be arranged so as not to interfere with or impede public traffic on all lanes intended to be kept open. Necessary signs and lights clearly indicating the lanes open to the public shall be maintained by the Contractor. When it is necessary to provide for traffic across the pavement, the Contractor shall construct a suitable and substantial crossing to bridge the concrete. The bridge shall be adequate for traffic and satisfactory to the Engineer. Any part of the pavement damaged prior to its

final acceptance shall be repaired or replaced by the Contractor in a manner satisfactory to the Engineer. The Contractor shall protect the pavement against public traffic and the traffic of its employees and agents.

501.16 Joints. Joints of the type and dimensions indicated shall be constructed at locations required by the Plans or Special Provisions.

(a) *Transverse Contraction Joints.* Transverse contraction joints shall be spaced at intervals no less than 2 m and no greater than 13.5 m, or as directed.

A load transfer device as shown on the Plans or an approved alternate design shall be placed across each contraction joint. The device shall include positive, rigid means for accurately positioning and adequately supporting the load transferring parts regardless of the nature of the foundation material. The positioning and supporting components shall be capable of resisting all normal forces imposed on joint devices during shipment, handling, installation, and during all the concrete operations. The dowels shall be installed and maintained parallel to each other and parallel to the pavement surface, and shall be placed midway in the depth of the pavement.

At least two weeks prior to concrete paving, the Contractor shall submit, for approval, a representative assembled load transfer device. The representative device shall be complete in all details including tools, installation equipment, and other appurtenances. When so directed, the Contractor shall maintain the approved representative device on the Project. All load transfer devices furnished for use on the Project shall be at least equivalent to the approved device.

The device shall be so designed that extreme accuracy in locating the saw-cut over the center of the device is not necessary for it to function properly.

When the load transfer device is in place on the foundation, it shall act as a rigid unit with each component part securely held in position relative to the other members of the assembly. The entire device shall be held securely in place during the placing, consolidating, and finishing of the concrete by means of metal stakes which shall penetrate the foundation at least 300 mm. At least ten stakes shall be used for each section of assembly that is between 3.0 and 3.6 m long. The Contractor shall check the horizontal alignment of the dowel bars by an approved means and the vertical alignment of each dowel bar by means of a leveling device. The leveling device shall be so constructed that it may be adjusted to the correct grade when set on the side forms. All deviations from correct alignment greater than 3 mm in 300 mm shall be corrected before any concrete is placed.

Care shall be exercised in depositing the concrete at the dowel bar assemblies so that the horizontal and vertical alignment of the assemblies will be maintained.

The load transfer device shall be fabricated from corrosion resistant, coated dowel bars conforming to AASHTO M 254, Type A or Type B coating. Type B fusion-bonded, epoxy powder coated dowels shall be lubricated at least one hour before the concrete is placed around the load transfer device. Each dowel bar shall be rendered bondless with an approved bond breaker. If a graphite lubricant paste is used, the paste shall consist of an approved mixture of flake graphite, oil vehicle, and dryers. The lubricant shall be applied to the dowels by daubing, mopping, or gloved hand to produce a coating approximately 1.6 mm thick. Brushes shall not be used to apply the lubricant.

Unless otherwise specified or directed, all transverse contraction joints shall be sawed. Sawing shall be done with approved sawing equipment. The saw shall be equipped with adequate guides, blades, guards, water cooling system, and a method of controlling the depth of cut. An adequate supply of water, and a standby saw in good working condition with an ample supply of blades shall be available at the site of the work during the sawing of contraction joints.

Joints shall be sawed in succession as soon as the saw can be operated on the pavement without damaging the surface or washing the mortar away from

the coarse aggregate adjacent to the joint. The sawing shall be regulated so that each joint is sawed at the proper time. Sawing shall continue until all joints in the newly placed concrete are completed. The joints shall be sawed completely from edge to edge of the pavement. When a membrane curing agent is used, the edge of exposed pavement shall be sprayed with the curing agent upon the completion of the sawing of joints. All transverse joints shall be sawed without delay to prevent uncontrolled random cracking, usually four to 24 hours after the concrete placement, depending on the weather. Adequate lighting shall be provided to facilitate sawing operations performed during the night. If the wet sawing method is used, the joint shall be flushed clean with water after the concrete has gained sufficient strength to preclude washing of mortar from the joint faces.

A chalk line or other suitable guide shall be used to mark the alignment of joints. The saw cut shall not vary more than 13 mm from true alignment. Where the pavement is built in two or more separately poured lanes, the joints shall be continuous for the full width of pavement.

A rolled crepe tissue paper, foam backer rod, or approved similar product, of suitable width shall be inserted in the joints immediately after the sawing and flushing operations have taken place.

(b) *Longitudinal Contraction Joints.* Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured on chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, approved hook bolts, or W-bolts, as specified on the Plans shall be used.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the Plans. Suitable guide lines or devices shall be used to ensure cutting the longitudinal joint on the true line as shown on the Plans. Sawing of longitudinal joints shall be performed prior to the widening of transverse joints in a two-stage sawing operation. The longitudinal joint shall be sawed not later than five days after the concrete has been placed and before any equipment or vehicles are allowed on the pavement. When a multiple lane pavement is being constructed, all required sawing of longitudinal joints shall be performed on the pavement in place before additional lanes are constructed. Sawing of longitudinal joints shall be continuous across all transverse joints. Whenever sawing is discontinued, the cut shall terminate at a transverse joint. The sawed area shall be thoroughly cleaned and the joint shall immediately be filled with sealer or approved backer rod.

(c) *Construction Joints.* The finished pavement shall be constructed to the full pavement width regardless of whether the fixed-form or slip-form method is used. Finished pavement in excess of 7.2 m wide and ramps or other pavement of non-uniform width shall be constructed in a manner to minimize formation of longitudinal construction joints. Transverse construction joints shall be constructed when there is an interruption of more than one hour in the concreting operations. Transverse construction joints shall not be constructed within 3 m of an expansion joint, contraction joint, or transverse plane of weakness. If necessary, an unanticipated construction joint shall be moved back to the last plan joint and the excess concrete removed and disposed of as directed.

Construction joints shall be formed by securing in place a removable bulkhead or header board, or alternatively as specified in Subsection 501.27. If a header board is used, it shall conform to the full cross-section of the pavement and shall be secured flush with the subbase and parallel to the normal transverse joints. The board shall be slotted or drilled to accommodate reinforcement as required by the Plans. The face of the form shall be oiled prior to concrete placement.

The roll of laitance and grout that usually forms in front of the paver shall not be used adjacent to transverse construction joints. Concrete adjacent to transverse construction joints shall be consolidated full width and depth using mechanical, hand-type, spud vibrators. One auxiliary vibrator shall be available for use in the event of mechanical malfunctions.

The Contractor shall stringline and correct variations of the concrete surface within 9 m on either side of transverse construction joints before the final finish is applied to the concrete. The surface shall be stringlined longitudinally. Surface deviations of more than 3 mm in 3.048 m, in any direction, shall be corrected while the concrete is in a plastic condition.

Longitudinal construction joints shall be constructed by skilled concrete workers using tooling devices and edging tools while the concrete is in a plastic state. The Contractor shall use methods and equipment that ensure that joint reinforcement is properly located and not disrupted during construction.

All construction joints, transverse and longitudinal, shall be tooled with rounded or beveled edges to a radius or length specified on the Plans, or as directed, to accept the required joint sealant. Any joint of insufficient size or radius, or of poor workmanship, shall be corrected and sealed as directed.

501.17 Surface Test. The surfaces of finished concrete pavements will be tested by the Engineer using either a rolling straightedge, a straightedge, or a California-type profilograph. The California-type profilograph will be used unless otherwise stated in the Contract. All surface variations that exceed the tolerances specified for the type of test will be corrected and all excessive roughness shall be corrected before the work will be considered acceptable.

(a) *General.* In the absence of the requirement for profilograph testing as specified in (b) below, surface testing will be performed with a rolling straightedge or a straightedge as described in the following paragraph. The finished surface of the pavement shall be within the tolerance of the following surface trueness test.

Finished concrete pavement will be tested by the Engineer for trueness in each wheel lane at the completion of the required curing or protection period. The surface will be tested by means of a rolling 3.048 m straightedge, or a 3.048 m straightedge placed parallel to the center line of the pavement, parallel to the grade line and touching the surface. Surface variations of the pavement measured by the 3.048 m rolling straightedge or measured from the base of the straightedge to the surface of the pavement shall not exceed 3 mm. Surface variations which exceed 3 mm up to and including 13 mm in 3.048 m will be marked and shall be removed by an approved grinding tool or a device consisting of multiple saws. The use of a bush hammer or other impact devices will not be permitted. Determination of pavement thickness will be made after the removal of high spots.

Areas which vary from the true surface by more than 13 mm shall be diamond grinded or removed and replaced with pavement of the specified quality and smoothness. When it is necessary to remove the pavement to eliminate surface variations, the sections removed shall be full lane width or the total width between longitudinal joints of the pavement, and shall be not less than 3 m in length. Pavement to be removed shall be saw-cut full depth along the faces of the patch. Pavement replaced shall conform to Section 501 in every respect.

(b) *Profilograph Testing.*

(1) *General.* This test is performed in accordance with Department's Materials Manual to provide a value (Profilograph Ride Index, or PRI) for the riding surface smoothness of a traveled way and to locate excessive deviations ("must-correct" areas) in the relative profile of the riding surface.

The areas subject to smoothness testing will be designated as

Primary Surfaces, Secondary Surfaces, and Shoulder Surfaces. Unless otherwise designated on the Plans, Primary Surfaces, Secondary Surfaces, Shoulder Surfaces, and surfaces not subject to smoothness testing are defined as follows:

a. Primary Surfaces will be the traveled way consisting of mainline pavements (width limited to lane widths as shown on typical sections), shoulders described on the Plans as future traffic lanes, bridge transition and approach slabs, bridge decks, connectors, and ramps with radii of curvature of at least 300 m.

b. Secondary Surfaces will be the traveled way consisting of full-width acceleration and deceleration lanes and ramps with radii of curvature less than 300 m.

c. Shoulder Surfaces shall be concrete shoulders of at least 1 m width.

d. Areas not subject to surface smoothness testing will be shoulders less than 1 m wide, driveways, parking areas, tapers, gore areas, and within 6 m of the ends of areas that lead to and leave from areas not subject to surface smoothness testing.

Any areas of riding surfaces not subject to surface testing using the profilograph will remain subject to other surface smoothness requirements of this Section.

(2) *Construction Requirements.* The profile of all areas subject to smoothness testing shall be within 25 mm of the plan design profile.

The Contractor shall identify the locations of the limits of each test segment as identified by the Engineer with approved permanent markings in the pavement. This identification may be a scribe mark made at the time of paving into the top surface of the plastic concrete near the side of the slab. This marking must remain visible until all of the riding surface testing is complete.

(3) *Initial Testing Schedule.* Upon acceptable completion of the construction of each test segment of Primary or Secondary Surface, including all patching and other such work which may change the measured smoothness of the riding surface, but before any grinding or other such surface altering work, the Engineer will test and evaluate the riding surface smoothness.

Testing will be performed as soon as practical after construction of a full test segment, after curing has progressed to the point that the test equipment can properly ride the surface, and after the Contractor has cleared the area and requested testing by the Engineer. Results of this first evaluation will include a listing of "must-correct" areas and an Initial PRI. These results will be available to the Contractor within three working days after the test has been performed. All profilograph traces for the Project will be available for the Contractor’s review at the Engineer’s field office.

(4) *Performance Requirements.* Each area having a deviation in excess of 7.5 mm above a reference line between two points which are up to 7.62 m apart on the traveled way surface constitute a "must-correct" area. The Engineer will report these deviations by station count where the approximate greatest deviation exists for each run made.

Prior to attempting to correct any "must-correct" area, the Contractor must receive approval for the proposed equipment and procedures from the Engineer. For bridge deck surfaces, the Contractor must furnish and use a pachometer to locate the top of the reinforcing steel prior to any corrective work. Generally, the Contractor may use

grinding equipment that utilizes diamond cutting blades gang-mounted on a self-propelled machine. As a requirement for approval, this equipment must have demonstrated previous successful use in grinding similar riding surfaces. The use of bush hammers or other impact devices will not be permitted. Any areas of spalls, aggregate fractures, disturbed joints, cross-slope discontinuities, or raveling pavement will not be accepted. Grinding work shall be performed parallel to, or at right angles to, the travel lane centerline. The final texture of the surface shall be acceptable to the Engineer in terms of cross-slope drainage, skid resistance, and appearance. Cross-slope deviations in excess of 3 mm over a baseline distance of up to 900 m will be unacceptable. In order to be accepted, the correction work may need to extend into adjacent test segments and into area not previously subject to profilograph testing.

The Contractor shall furnish and use a California-type profilograph to determine the limits of the proposed correction work for each "must-correct" area identified by the Engineer. The Contractor shall also evaluate the success of the attempted correction work with this equipment.

In addition to "must-correct" work, the Contractor may attempt to improve the PRI of a test segment. Prior to receiving acceptance of nonconforming test segments and prior to attempting to improve the PRI of a test segment, the Contractor must acceptably correct all "must-correct" areas in the test segment and present to the Engineer an acceptable profilograph trace of the full length of the test section showing satisfactory results of the correction efforts. The Engineer reserves the right to use one working day to validate this evaluation. In case of disagreements, the standard equipment used for acceptance of the correction work shall be the Engineer’s California-type profilograph and bump template. Should the Engineer’s validation work reveal a lack of conformance to these requirements, the Contractor shall perform adequate corrections and shall request another evaluation by the Engineer. The cost to the Contractor for the Engineer to validate acceptable correction of "must-correct" areas is indicated in Subsection 501.40 (d).

Also prior to attempting to improve the PRI of a test segment, the Contractor must receive approval from the Engineer for the proposed procedures and for the proposed individual locations of corrective work for the test segment. Generally, the Contractor may use similar procedures as those used for correcting "must-correct" areas and must meet the same final performance requirements for work at "must-correct" areas. The Contractor, in attempting to improve the PRI, should address the most rough areas within and immediately adjacent to the segment so that an evenly smooth traveled way results. The roughest areas may, or may not, be located where "must-correct" areas had existed. When the Initial PRI is acceptable (although a negative pay adjustment may be assessed), correction of "must-correct" areas alone may not be considered acceptable in attempting to improve the PRI. The Engineer will complete the evaluation of the improvement plan within three working days after it was received.

(5) *Final Testing and Work Schedule.* As soon as practical after the Contractor performs PRI improvement work and requests another PRI determination from the Engineer, the Engineer will evaluate the smoothness of the test segment riding surface (but not necessarily before the Engineer has completed outstanding work in determining Initial PRI and validating "must-correct" correction work of other test segments). The result of this evaluation will be a Final PRI. This result will be available to the Contractor within three working days

after the test has been performed.

If any "must-correct" deviations exist when the Final PRI is determined, the Contractor must correct them before that segment will be accepted for payment. In order to receive acceptance of any such segment after correction, the Contractor must request additional testing by the Engineer. The cost to the Contractor for the Engineer to validate acceptable correction of "must-correct" areas is indicated in Subsection 501.40 (d).

Should the total area of patching (full depth or partial depth) exceed 4.5 m^2 of the surface within a test segment, this patching occurring after the Engineer has performed PRI testing, that PRI value is no longer valid; the Contractor must request additional testing to determine a Final PRI. Regardless of the value of the Initial PRI (or the Final PRI, if that value was also determined), patching which requires retesting shall result in the Contractor requesting another PRI determination.

The Contractor has the option of requesting extra profilograph testing in addition to the runs provided by the Engineer. There will be a cost for this work as described in Subsection 501.40 (d). Also, there may be a delay before this work is completed.

Damage to joint sealants, striping, etc. caused by corrective work performed on the riding surface shall be acceptably repaired by the Contractor.

Determination of the pavement thickness will be performed after all corrective work is completed.

The Engineer will perform the work as soon as practical upon the Contractor’s request but not necessarily before the Engineer has completed outstanding work in determining Initial PRI’s. For scheduling purposes, the Contractor may expect the Engineer to evaluate about five test segments during a normal work day with acceptable environmental conditions. The Engineer will advise the Contractor of the results of these PRI determination tests within three working days and within one working day for validation of acceptable correction of "must-correct" areas.

501.18 Sealing Joints. Final sealing of all sawed, formed, or tooled longitudinal and transverse contraction and construction joints shall be done after all construction traffic has finished using the pavement. Transverse joints shall be filled with an approved backer rod prior to any vehicular traffic using the pavement. No widening of the joint shall be performed until construction traffic has been eliminated from the pavement. The type of pavement joint sealant to be used shall be as shown on the Plans or specified in the Special Provisions. Prior to sealing, each joint shall be thoroughly cleaned for the full depth of the saw cut by brushing, oil-free compressed air, sand blasting, or other means. The cleaning shall completely remove all traces of laitance, curing compound, saw residue, dirt, and all foreign material, in accordance with the recommendations of the sealant manufacturer.

All doweled transverse construction joints shall be sawed to the configuration of a contraction joint and sealed. Transverse construction joints tied with deformed bars may be tooled or sawed as directed, and sealed.

(a) *Longitudinal Joint Sealant.* All longitudinal joints in the finished concrete pavement shall be sealed with hot-poured joint sealant to the configuration shown on the Plans.

All sawed joints to be sealed with hot-poured joint sealant shall utilize a polyethylene or urethane foam rod, or other approved bond breaker, sufficiently heat resistant to develop the required parabolic sealant shape and depth.

Construction joints shall be tooled and sealed as shown on the Plans. Immediately prior to installation of the backer rod and joint sealant, each joint shall be air blown, clean and dry.

Hot-poured joint sealant shall be placed in conformance with the

manufacturer's recommendations concerning joint cleaning, application, and safe heating temperature.

For rounded or beveled joints, the sealant shall be installed to a depth as shown in the Standard Construction Details.

The sealing material shall be applied to each joint opening in accordance with the details shown on the Plans or as directed. Application shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. All excess material on the surface of the concrete pavement shall be removed immediately, and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Hot-poured joint sealing material shall not be placed when the air temperature in the shade is less than 10 C, unless approved by the Engineer.

(b) *Transverse Joint Sealant.* All sawed transverse joints in finished Portland cement concrete pavement shall be sealed with preformed compression seals. The equipment shall be as recommended by the manufacturer of the seal and approved by the Engineer before construction is permitted to start.

Detailed design or configurations of the seals will not be specified. The Contractor shall submit the design details of the proposed seal for the Engineer's approval prior to the seal's delivery to the Project site. This approval must be requested in writing. In addition, the Contractor shall furnish a 1.5 m sample section of the seal. The manufacturer shall certify that the seals comply with the specifications. Test data must be submitted in writing to the Department to support the certification. The size of the seal for a transverse joint shall be 30 mm (uncompressed width) in a 16 mm joint.

Transverse joints may be constructed by stage sawing or by sawing the joint 16 mm wide initially. Transverse sawing should be done as soon as possible without damage to the concrete surface. When transverse joints are constructed in two stages, the second-stage sawing will not be permitted until the concrete is at least three days old. All saw cuts must be made the full width of pavement. Decreasing the depth of saw cut at pavement edges to eliminate the need for form removal will not be permitted. In addition, scoring the area to be sawed with a trowel is also not permitted. Forms, if used, must be removed from the location of the saw cut.

When transverse joints are constructed by the two-stage method, the Contractor should be prepared to vary the width of the secondary cut. The additional width of the cut required will be equal to the width of the cracked joint below the initial saw cut. The Contractor must coordinate its final sawing and seal insertion so that a 16 mm minimum width joint results. The Contractor will not be permitted to install seals in joints less than 16 mm wide.

The edges of the transverse joints shall be beveled 45 degrees. Permissible tolerances for the bevels are 3 to 6 mm measured along the pavement surface. Should non-uniform width cracking occur at transverse joints, the Contractor may be required to supply and install wider neoprene seals in accordance with manufacturers recommendations.

The joints shall be sealed immediately following the curing period, or as soon thereafter as weather conditions permit. At the time of application of the compression seals, the atmospheric and pavement temperatures shall be above 4 C. The sealing can continue as long as the joints do not have water in them.

The equipment for cleaning joint openings shall consist of plows, powered and hand brooms or wire brushes, air compressors, and if necessary, joint cleaning and grooving machines to produce a satisfactory, clean and dry joint.

Before sealing the joints, the Contractor shall demonstrate that the equipment and procedures for placing the compression seal will provide a satisfactorily sealed joint. The top outer edges of the seal should be in contact with the joint faces. There should be no tendency for the seal to roll towards its center.

Installation of seals manually will not be permitted. Machine installation will be required. The installation equipment for the elastic joint seal material shall be fabricated for that purpose. The installation equipment shall be capable of installing the seal in the joints, with the vertical axis of the seal being parallel to the joint interfaces, without twisting, curling, or nicking of the seal, and shall ensure against the seal being in tension within the joint.

A lubricant shall be used to install the preformed elastic joint seal. Each lot of the lubricant shall be delivered in containers plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture. The Contractor shall submit the manufacturer's certification that the lubricant conforms to the requirements of Subsection 808.02. The elastic seal shall be installed in the joints with the lubricant covering both sides of the seal over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the concrete or seal, or both.

The seal shall be installed in a compressed condition at a depth of not less than 5 mm but not more than 8 mm below the surface of the pavement. The transverse seal shall be placed first.

In transverse joints, the seal shall extend the full width of the pavement without cuts or splices. In three or more lane sections, splices shall be staggered from longitudinal or adjacent joints by 300 mm. Seals shall not be spliced between adjacent joints or slab edges.

The method of installation shall be such that the joint seal shall not be stretched more than 5% of its minimum theoretical length. The method of installing the transverse joint seal shall be checked for stretching. The check shall consist of installing the seal in five joints of full pavement width, and then removing the seal immediately after installation and checking the length. If the measured length of any of these five seals is less than 95% of the length required to seal the joint, the installation method shall be modified so that stretching greater than 5% no longer occurs. Once sealing operations have started, one joint per hundred shall be removed and checked for stretch in excess of 5%. If a stretched condition is detected, the joint seals on either side shall be removed until the condition disappears. The affected joints, including the checked joints, shall be resealed in a satisfactory manner.

501.19 Opening to Traffic. The pavement shall be closed to traffic for not less than ten days after the concrete is placed. The Engineer may elect to close the pavement to traffic for a longer period of time if weather conditions make it advisable to do so. The pavement may be opened to traffic prior to the expiration of the ten-day period when the compressive strengths of representative cores taken by the Department indicate that the strength of the pavement exceeds 25 MPa.

501.20 Tolerance in Pavement Thickness. For the purpose of establishing an adjusted unit price for pavement lanes, units to be considered separately are defined as 300 m of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 300 m plus the fractional part of 300 m remaining. One core in each unit will be taken at random by the Department. When the measurement of the core from a unit is not deficient more than 5 mm from the plan thickness, full payment will be made. When such measurement is

deficient more than 5 mm and not more than 25 mm from the plan thickness, two additional cores, at intervals not less than 15 m on either side of the short core, will be taken and used to determine the average thickness for that unit. An adjusted unit price, as provided in Subsection 501.40, will be paid for the average thickness of pavement.

Areas other than pavement lanes, such as intersections, entrances, crossovers, and ramps, will be combined into 800 m^2 units. The thickness of each combined unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each 800 m^2 of pavement, or fraction thereof, in the unit. If the core so taken is not deficient more than 5 mm from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 5 mm but not more than 25 mm from the plan thickness, two additional cores at random will be taken from the area represented and the average of the three cores determined. If the average thickness of these three cores is not deficient more than 5 mm from the plan thickness, full payment will be made. If the average thickness of the three cores is deficient more than 5 mm but not more than 25 mm from the plan thickness, an adjusted unit price as provided in Subsection 501.40 will be paid for the area represented by these cores.

For all pavement areas, in calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 5 mm will be considered as the specified thickness plus 5 mm. Measurements which are less than the specified thickness by more than 25 mm will not be included in the average. When the measurement of any core is less than the specified thickness by more than 25 mm, the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 3 m intervals parallel to the centerline in each direction from the affected location until in each direction a core is found that is not deficient by more than 25 mm. Areas found deficient in thickness by more than 25 mm shall be evaluated by the Engineer. If, in the Engineer's judgment, the affected areas warrant removal, these areas shall be removed and replaced with concrete of the thickness shown on the Plans.

CONSTRUCTION METHODS FOR SLIP-FORM PAVING.

501.21 Prepaving Meeting. At least seven days prior to the construction of any pavement with the slip-form method, the Contractor shall conduct a prepaving meeting with the Engineer and other involved parties. Topics of discussion shall include a review of the Specifications, proposed equipment, and contingency plans in case of various possible problems.

501.22 Preparation of the Base Course. Preparation of the base course shall conform to the requirements of Subsection 501.03; and, fine grading of the foundation and setting of the grade and alignment controls shall be completed for a distance of at least 300 m before any slip-form paving may begin.

501.23 Limitations of Mixing. Limitations of mixing shall conform to the requirements of Section 812.

501.24 Construction Equipment. Construction equipment for slip-form paving shall conform to the requirements of Subsection 501.05 and the following. The Contractor shall use at least one approved mechanical concrete spreader in advance of the slip-form paver. The spreader shall be independently powered and capable of spreading the concrete over the minimum width and depth of the placement area, as shown on the Plans, in a manner which will prevent segregation of the materials. The spreader shall be of such design and construction as to permit the striking-off of the concrete to a uniform thickness. No single lane placement will be permitted in mainline areas except for acceleration/ deceleration or "third lane" areas.

The Contractor shall use only a slip-form paver that has been approved by the Engineer prior to its delivery to the Project site. The slip-form paver shall be fully self-propelled, equipped with crawler type tracks, and designed so that the pavement line and surface elevation are automatically controlled by a sensor contacting a taut string or wire. The paver shall be readily and accurately adjustable as to crown and superelevation, and be able to shape and compact concrete to the required cross-section in transitions.

The paver shall be of sufficient size, weight, power, and gearing in order to furnish the needed pressure to the surface of the concrete while negotiating the expected grades and requirements for at least 7.2 m wide concrete placement and while finishing without track slippage. No tractive force shall be applied to the paving machine except that which is controlled from the paving machine.

Vibrators, for full-width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, grade, or side forms. The frequency of the surface vibrators shall not be less than 3500 impulses per minute, and the frequency of the internal type shall not be less than 5000 impulses per minute for tube vibrators and no less than 7000 impulses per minute for spud vibrators.

The paver shall have a vibrating screed or pan to operate on the surface of the concrete. The paver must be so equipped that when the forward motion is interrupted, all vibration equipment stops.
Sliding forms of sufficient shape, dimension, and strength behind the paver may be required for such a distance that no appreciable slumping of the concrete will occur. The sliding forms if needed shall be rigidly held together laterally to prevent spreading of the forms.

The Contractor may elect to submit for approval a slip-form paver having an automatic dowel bar inserter (DBI). If approved, use of the DBI would eliminate the need for pre-assembled load transfer devices. Should a DBI be approved for use, the Engineer will give consideration to place concrete directly from delivery trucks onto the grade in front of the advance spreader if the Contractor desires and can propose and demonstrate successful protection of the base course. In no case may the base course be used as a haul road. If approved by the Engineer, the concrete trucks would enter onto the base course just in front of the paving equipment and would exit from the base course as soon as possible after placement of the concrete. If a DBI is proposed and approved, use of an advance spreader may be eliminated if the Contractor can demonstrate techniques to properly protect the base course, during concrete placement, achieves acceptable rideability numbers, and meets all other criteria required for slip-form paving. The Department reserves the right to require use of an advance spreader in conjunction with a paver having DBI capabilities should initial paving runs with the DBI machine prove unsuccessful as determined by the Engineer.

An advance spreader will be required for slip-form paving operations whenever pre-assembled load transfer devices are utilized.

501.25 Forms and Form Setting. Forms and form setting for slip-form paving, if required, shall conform to the requirements of Subsection 501.06.

501.26 Preparation for Placing Concrete. Paving shall be stopped and a transverse construction joint installed whenever paving comes to within 60 m of completed preparation, except for the ends of the design pavement.
When placing concrete next to existing concrete pavement, the wheels of the equipment shall be adjusted to provide full bearing on the existing pavement and extended to prevent breaking the pavement edge. Edge of pavement shall be beveled before allowing equipment to run on edge. The existing concrete shall have attained a minimum compressive strength of 20 MPa as determined by representative cylinders.

The location of the load transfer devices shall be accurately marked to ensure sawing the transverse joints over the center of the dowels. A pachometer will be utilized to verify load transfer dowel locations. The Contractor shall provide a suitable pachometer as approved by the Engineer.

The Contractor shall employ an adequate number of persons trained in the operation and maintenance of slip-form paving equipment.

The Contractor shall have on hand at least 30 m of temporary forms to immediately bulkhead the pavement edges to prevent possible slumping of the concrete at the pavement edges.

The Contractor shall also have on hand a transverse bulkhead for placement of a transverse construction joint in case of an emergency stop or interruption in work.

501.27 Placing Concrete. Whether or not a DBI is used, vertical, longitudinal, and horizontal translation, and vertical and horizontal rotation will be checked by the Department for compliance with the Standard Construction Details.
These tolerances will be checked by the Department during the paving operation while the concrete is still plastic and also after the paving is completed by use of a pachometer. Initial testing will be performed on the first day’s paving run. Should any of the parameters be out of tolerance, additional use of the DBI will be prohibited until the Contractor proposes corrective methods acceptable to the Engineer. The Department reserves the right to require full depth patch replacement and new installation of dowel bars at any joint where it is determined that dowel bar locations are out of specification to the extent that future pavement failure could occur as a result of the dowel location.

The concrete may be placed by the spreader in one lift, if so desired, to roughly the full depth of the pavement. If the Contractor uses a DBI, the concrete may be deposited directly from the concrete delivery trucks onto the grade, if approved by the Engineer, to roughly the full width and depth of pavement, or an advance spreader may be utilized. The slip-form paver shall bring the concrete to final elevation and shall finish it in accordance with this Section.

If the Contractor elects to place the concrete in two equal layers, the top layer of concrete shall be placed and immediately struck off before the bottom layer becomes nonplastic. Any portion of the bottom layer of the concrete which has become nonplastic, or has been placed more than 20 minutes without being covered with the top layer, shall be removed and replaced with freshly mixed concrete. Each lift must be placed by an approved spreader in advance of the final paver.

The slip-form paver shall be operated with as nearly a continuous forward motion as possible, and all operations of mixing, delivering, and spreading the concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum.

The load transfer dowels for a transverse construction joint shall be placed as in accordance with the Plans and Specifications before the effected concrete sets (loses plasticity). The joint installation must be completed while the concrete is still plastic and workable.

Should placement of concrete be interrupted for a period exceeding 30 minutes, a transverse construction joint shall be installed. Material shall be removed by sawing the concrete full depth and full width to create a vertical face. The location of the transverse construction joint shall occur at the planned location of a transverse joint, or is at least 3 m from any existing or planned transverse contraction joint. Dowels would then be inserted by drilling and anchoring using methods and materials approved in advance by the Department. Should the construction of the transverse construction joint not meet requirements, the concrete placed in the area shall be completely removed to the nearest acceptable joint and a full-depth, full lane width, tied concrete patch shall be constructed by the Contractor as directed by the Engineer.

501.28 Consolidating and Screeding Concrete. Consolidating and screeding concrete shall conform to the requirements of Subsection 501.08.

501.29 Finishing. The amount of manipulation of the mix shall be held to the minimum required to bring the concrete to a proper finish.

The elevation of a new pavement edge placed adjacent to an existing pavement shall conform as closely as possible to the elevation of the existing pavement edge. Any difference in elevation which may cause ponding of water on either side of the contact joint shall be eliminated by finishing the new pavement within 300 mm of the existing pavement by hand methods, adding or removing concrete as necessary while the concrete is still plastic and no greater than 20 minutes after placement.

501.30 Placement Performance Requirements. Several performance characteristics shall warrant the Engineer's ordering the Contractor to halt the paving operations. Unless the Contractor can modify the operations in a manner which produces satisfactory performance, the use of the slip-form method of pavement construction shall be discontinued, and the pavement shall be properly repaired and constructed by means of the fixed-form method. Unsatisfactory performance characteristics shall include, but are not limited to, the following:

(a) Failure of the Contractor to maintain a continuous forward movement or consistent height of mix across the face of the screed or both;

(b) Failure of the Contractor to prevent excess edge slump (greater than 6 mm, exclusive of the edge rounding). Edge slump will be tested by placing a 3.048 straightedge perpendicular to the centerline of the pavement and taking a vertical measurement from the bottom of the straightedge to the surface of the concrete. Edge slump will be tested while the concrete is still plastic;

(c) Failure of the Contractor to construct a smooth finished surface of pavement; and

(d) Failure of the Contractor to maintain an edge of pavement within 45 mm of the specified horizontal alignment or to maintain any change in horizontal alignment within a rate of change of 1 in 50.

The surface variations of edge slump exceeding allowable tolerances shall be corrected by the Contractor, using approved methods.

501.31 Curing. Curing shall conform to the requirements of Subsection 501.10.

501.32 Protection Against Rain. Protection against rain shall conform to the requirements of Subsection 501.14.

501.33 Protection of Concrete. Protection of concrete shall conform to the requirements of Subsection 501.15.

501.34 Joints. Joints shall conform to the requirements of Subsection 501.16.

501.35 Surface Test. Surface testing shall conform to the requirements of Subsection 501.17.

501.36 Sealing Joints. Sealing joints shall conform to the requirements of Subsection 501.18.

501.37 Opening to Traffic. The pavement shall conform to the requirements of Subsection 501.19 prior to opening to traffic.

501.38 Tolerance in Pavement Thickness. Tolerance in pavement thickness shall conform to the requirements of Subsection 501.20.

501.39 Method of Measurement. The quantity of Portland cement concrete jointed pavement will be measured as the number of square meters completed and accepted. The width for measurement will be the width of the pavement shown on the typical cross-section of the Plans, the width of the additional widening where called for, or the width as otherwise directed in writing. The length will be measured on the surface along the centerline of each roadway or ramp.
The quantity of pavement subjected to surface smoothness testing will be measured as the total surface area in square meters of all the test segments. The test segments will be continuous, but not overlapping, throughout the Project, interrupted only by areas not subject to smoothness testing. The length of each test segment will be the actual length of the segment. The total width of the test segments will be limited by the width of the traveled way indicated by the striping plan. The width of the surface material placed during the same construction operation will not alter this limitation.
Wire reinforcement, dowels, tie bars, hook bolts, load transfer devices, cleaning, sawing, tooling, and sealing of joints will not be measured.

501.40 Basis of Payment.

(a) *General.* The accepted quantity of Portland cement concrete jointed pavement will be paid for at the Contract unit price per square meter. Price and payment will constitute full compensation for furnishing and placing all materials, constructing all joints, curing concrete, installing and testing seals, constructing temporary bridges for access to the work, patching and installing new dowel bars at joints where dowel bar locations are out of specification, rescarifing hardened foundation, removing and replacing rejected concrete pavement, repairing substandard concrete pavement, and all labor, equipment, and incidentals required to complete the work.

(b) *Price Adjustments for Thickness Deficiency.* Where the average thickness of pavement is deficient in thickness by more than 5 mm, but not more than 25 mm, payment will be made at an adjusted price as specified in the following table:

Table 501-A

Price Adjustments for Concrete Pavement Thickness Deficiency

Deficiency in Average Pavement Thickness Determined by Cores (mm)	Proportional Part of Contract Unit Bid Price (%)
0.0 to 5.0	100
5.1 to 8.0	80
8.1 to 10.0	72
10.1 to 13.0	68
13.1 to 19.0	57
19.1 to 25.0	50

When the thickness of pavement is deficient by more than 25 mm and the judgement of the Engineer is that the area of such deficiency should not be

removed and replaced, there will be no payment for the area retained.

No additional payment over the unit Contract price will be made for any pavement which has an average thickness in excess of that shown on the Plans.

(c) *Price Adjustments for Smoothness of Riding Surface.* Payment for the work containing Primary and Secondary Surfaces will be adjusted in a manner that relates to the measured smoothness of the riding surface, as described in the following paragraphs.

No payment will be made for any subject area which has not been properly evaluated. No payment will be made for any segment which contains any "must-correct" areas. No payment will be made for any segment which has an excessively high PRI as indicated by the Payment Adjustment Schedules below. No payment will be made for repairs to damaged joint sealants, striping, etc. caused by corrective work performed on the riding surface.

Values as calculated from the Payment Adjustment Schedule for a segment's Initial PRI will be used as a basis for payment adjustment only when the Contractor does not request a Final PRI determination.

Values as calculated from the Payment Adjustment Schedule for a segment's Final PRI will be used when the Contractor requests a PRI determination after an Initial PRI was determined, or when the Contractor has attempted an improvement of the segment's PRI after the initial construction of the test segment.

There may be negative adjustment values and, when the Initial PRI is used as a basis of adjustment, there may also be positive adjustment values for each of the test segments. The final total adjustment for the Project will be the addition of all the individual adjustment values calculated for all the test segments.

Table 501-B

Payment Adjustment Schedule for Primary Surfaces

Initial PRI (mm/km)	Contract Unit Price Adjustment (per m^2)
Less than 50	$1.50
50 to 200	($0.02) multiplied by (125 minus "Initial PRI")
Greater than 200	Corrective Work Required
Final PRI (mm/km)	**Contract Unit Price Adjustment (per m^2)**
Less than 40	$1.20
40 to 175	($0.02) multiplied by (100 minus "Final PRI")
Greater than 175	Additional Corrective Work Required

Table 501-C

Payment Adjustment Schedule for Secondary Surfaces

Initial PRI (mm/km)	Contract Unit Price Adjustment (per m^2)
Less than 100	$1.50
100 to 250	($0.02) multiplied by (175 minus "Initial PRI")
Greater than 250	Corrective Work Required

Final PRI (mm/km)	Contract Unit Price Adjustment (per m^2)
Less than 90	$1.20
90 to 225	($0.02) multiplied by (150 minus "Final PRI")
Greater than 225	Additional Corrective Work Required

Table 501-D Smoothness Requirement Schedule for Shoulder Surfaces	
Initial PRI (mm/km)	
Greater than 200	Corrective Work Required
Final PRI (mm/km)	
Greater than 175	Corrective Work Required

Other than through the above described payment adjustment, there will be no additional payment for the work involved for any "must-correct" area, or for the attempted PRI improvement work, for any areas or segments.

(d) *Profilograph Costs.* All profilograph testing work by the Contractor shall be performed at no additional cost to the Department.

The Engineer will perform profilograph testing work, at no cost to the Contractor, to determine the Initial PRI, to determine one Final PRI, and, at the option of the Engineer, to validate (for each test segment) one set of the Contractor's profilograph traces which showed acceptable correction of "must-correct" areas.

The Engineer reserves the right to perform other profilograph work, at no cost to the Contractor, for research purposes. The results of this research work will have no impact on the acceptability of, or the pay adjustments for, the Contractor's work.

The Contractor may request extra work to be performed by the Engineer; there will be a cost for this work. The cost for determining the PRI shall be $500.00 per test segment. The cost for validating acceptable correction of "must-correct" areas shall be $250.00 per test segment. These costs will be deducted from the Contract payments to the Contractor.

(e) *Price Adjustment for Low Strength Concrete.* Concrete which fails to

reach full 28-day design strength (f'_c) shall be subject to remedial action and prorated payment as specified in Subsections 602.25 and 602.27 respectively.

SECTION 502 RESERVED

SECTION 503 PATCHING PORTLAND CEMENT CONCRETEPAVEMENT

503.01 Description. This work consists of saw cutting, removing and disposing of existing Portland cement concrete pavement, and replacing it with new Portland cement concrete pavement.

MATERIALS

503.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class A or Class B.

Class A concrete shall have a minimum temperature of 24 C at the time of placement and a compressive strength of 15 MPa in six hours as measured by Sure-Cure Mold test cylinders. The Sure-Cure Mold test cylinders and all associated equipment shall be provided by the Contractor; the concrete will be sampled and tested by the Engineer. The following shall be the mix-design for Class A concrete:

Cement Content: 474 kg/m^3 (11.1 sacks/m^3)

Water to Cement Ratio by Weight: 0.34 to 0.38

Air Content: 3 to 7%

Crushed Stone to Sand Ratio by Volume: 0.60 to 0.70

Slump: 50 to 125 mm

Admixture: Either (a) or (b) noted below:

(a) A combination of 900 to 1800 g of Type E water reducing accelerating admixture per sack of cement, and 85 to 140 g of Type A water reducing admixture per sack of cement.

(b) A combination of 900 to 1800 g of Type E water reducing and accelerating admixture per sack of cement, and 85 to 140 g of Type D water reducing and retarding admixture per sack of cement.

Class B concrete shall be used for conventional concrete patching when early opening to traffic is not specified or required. Class B concrete shall have a minimum temperature of 24 C at the time of placement and a compressive strength of 15 MPa in 72 hours. Class B concrete shall conform to the following requirements:

Air Content: 3 to 7%

Slump: 50 to 125 mm

The consistency of Portland cement concrete, Class A or Class B, shall conform to the requirements of Subsection 812.04, except as noted above.

503.03 Bar Reinforcement. Deformed bar reinforcement shall be No. 15M bars conforming to the requirements of Subsection 824.02. Dowel bars shall conform to the requirements of Subsection 824.02.
Bar reinforcement for patching of continuously reinforced Portland cement concrete pavement shall conform to the requirements of Subsection 824.02. If longitudinal reinforcement bars are required, they shall conform to the requirements of ASTM A 615/A 615M, Grade 420, and shall be a minimum of 12 m in length. If transverse reinforcement bars are required, they shall conform to the requirements of ASTM A 615/A 615M, Grade 300 or 420.

503.04 Wire Mesh. Wire mesh reinforcement shall conform to the requirements of Subsection 824.02. If approved by the Engineer, fiber reinforcement may be substituted for the wire mesh. The fiber shall conform to the requirements of Subsection 824.02 and be introduced at a rate of 0.89 kg/m^3 at the production plant to allow dispersion of the fibers in the concrete.

503.05 Joint Sealants. Hot-poured joint sealant shall conform to the requirements of Section 808. Low-modulus silicone rubber joint sealant shall conform to the requirements of Section 808.

CONSTRUCTION METHODS

503.06 Patching Limits. The areas of old pavement to be patched will be indicated on the Plans, or identified by the Engineer.

The limits of the area where the pavement is to be removed and patched will be painted on the existing pavement by the Department.

Patches can be either Type I or Type II. A Type I patch is 4.8 m or less in length and contains no wire mesh. A Type II patch is greater than 4.8 m in length and contains wire mesh. The type of patch required will be designated on the Plans.

503.07 Conventional Concrete Pavement. The minimum length of the area to be repaired, measured along the centerline of pavement, shall be not less than 1.8 m. The pavement slab adjacent to the section being repaired shall be cut to a true, neat line with straightedges, perpendicular to the longitudinal centerline of pavement and perpendicular to the plane of the finished foundation. An approved diamond blade concrete saw shall be used to sever the patch area from the existing pavement. The existing pavement shall be removed by sawing the slab along the lines of the limits of the area to be patched, making a vertical cut to the full depth of the pavement to produce a straight, clean, vertical face. The concrete in the patch area shall be lifted out using locking keys and lifting pins or other devices inserted into holes drilled through the concrete to be removed. Additional lift-out clearance can be achieved by making wide cuts inside the patch boundaries and diamond blade saw cuts using a wheel cutter with carbide steel tips. When the lift-out method is not feasible, concrete in the patch area shall be broken by an approved mechanical pavement breaker or light jackhammers. When removing the old pavement, the foundation shall not be disturbed below the elevation of the bottom of the new concrete patch.

All removed concrete shall become the property of the Contractor and shall be disposed of according to the requirements of Section 106.09.

503.08 Foundation Preparation. The foundation shall be cut to the desired elevation to eliminate the necessity for backfilling. The foundation shall then be properly shaped, compacted, and brought to a firm and unyielding surface by tamping or by other approved methods to meet the requirements of Subsection 302.04 (c). Upon removing the existing pavement, if the foundation materials are found unsatisfactory, the Engineer may direct that the unsuitable material be removed and replaced with approved material. The replacement material shall be placed and compacted as required under Subsection 202.05 or as specified on the Plans.

The foundation shall be sprinkled to be moist, but not muddy, at the time of placing concrete.

503.09 Placing Concrete. Portland cement concrete shall be placed according to the requirements of Subsection 501.07. The concrete shall be deposited directly on the foundation and shall be uniformly distributed and spread over the entire foundation.

The type and size of side forms and methods of setting shall conform to the requirements of Subsection 501.06, except that the patches shall be constructed in single lane widths unless otherwise directed. Timber forms may be used where required. Forms are required in all areas, such as along the shoulders, where existing conditions will not provide a completed patch with smooth, vertical sides.

In order to accomplish 15 MPa compressive strength in six hours for Class A concrete, the Contractor shall establish actual combination of weights and proportion of admixtures as required by the field conditions, ambient temperature, humidity, and wind conditions. If because of unfavorable ambient temperature the concrete is unable to achieve the desired strength in six hours, the Contractor may reschedule for proper conditions to perform the patching work. Also, the Contractor shall contact the Department’s Materials and Research Section for consultation when the ambient temperature/concrete temperature is expected to rise above 27 C during the construction of Type II patching.

503.10 Consolidating and Finishing Concrete. It is intended that the amount of manipulation be held to the minimum required to bring the concrete to a proper finish. Short patches that are generally less than 3.6 m can be screeded either transversely or longitudinally. If a pavement is rutted, screeding in the longitudinal direction (placing the screed parallel to the centerline) may be directed by the Engineer so the patch matches the existing cross-section of the pavement. For patches over 3.6 m in length, the screed shall be placed perpendicular to the centerline.

As soon as the concrete has been deposited, it shall be leveled and immediately struck off by means of vibratory screeds or templates. The first or forward screed shall not be less than 250 mm in width, shall be from 450 to 600 mm longer than the width of the pavement, and shall be constructed of a channel iron weighing not less than 37 kg/m, or other approved design. The second or follow up screed shall not be less than 200 mm in width, shall be of the same length and construction as the first screed, and shall weigh not less than 27 kg/m, or other approved design. These screeds shall be shaped to the approved cross-sections and shall be of sufficient strength to retain their shape under all working conditions. During the screeding operation, the second screed shall follow the first screed at a reasonable distance as determined by the Engineer. The screed shall be moved forward with a combined longitudinal and crosswise motion. If necessary the screeds shall be used a second time or until a true surface is obtained. While the concrete is being struck off, at least two workers shall be at work leveling, spading, and tamping the concrete directly in front of the screed. Hand spud vibrators shall be used to facilitate consolidation of the concrete.

503.11 Joints. Filler material shall conform to the requirements of AASHTO M 153, Type I or Type II and shall be placed directly against face of the existing concrete. For Class A concrete the joint filler shall be 13 mm thick, and for Class B concrete, the joint filler shall be 19 mm thick. The filler material shall extend the full width of the patch, and from the bottom of the existing pavement slab to within 19 mm of the top concrete surface.

When specified on the Plans, all transverse joints shall have deformed steel tie bars and coated dowel bars installed as shown in the Plans. Tie bars shall be 450 mm long. Dowel bars shall be 32 mm diameter and 450 mm long. Tie bars and dowel bars shall be drilled into the face of the existing pavement by approved methods. Each tie bar and dowel bar must be placed parallel with the centerline of slab, both vertically and horizontally. A guide shall be used during the drilling of the holes into the existing slab to guarantee conformance with this requirement. Dowels shall be grouted in place with an approved material. The end of the dowel bar that will be in the new concrete shall be coated with grease or graphite paste.

No tie bar to adjacent concrete pavement slabs at longitudinal joints is required except when removing and replacing less than the full slab width. A bond breaker shall be placed on all concrete faces along the longitudinal joints exposed within the patch. A coat of approved latex paint or an approved alternate system may be used.
For patches longer than 4.8 m in the longitudinal direction, wire mesh reinforcement of longitudinal 4.06 mm wire spaced at 150 mm on center and transverse 5.74 mm wire spaced at 300 mm on center shall be used. The mesh shall be placed resulting in 75 to 100 mm of concrete cover to the surface and sides of the patch.

All transverse and longitudinal joints within the existing concrete pavement that extend through the patch area and the surface edges of all patches adjacent to the existing concrete pavement shall be tooled, formed, sawed, and cleaned to result in a properly dimensioned reservoir for sealant. The dimensions of the sealant reservoir shall be 13 by 19 mm. A bond breaking material, such as tape or a rod, shall be placed on the bottom of the reservoir prior to placement of the sealant system, in order to allow bonding of the system material to only the vertical surfaces of the concrete in the reservoir. All joints so constructed and to be overlaid with hot-mix shall be sealed with hot-poured joint sealant within five working days of concrete placement prior to placement of the overlay hot-mix. All other joints remaining exposed as part of the existing concrete pavement shall be sealed according to the requirements of Subsection 501.18 with low-modulus silicone rubber joint sealant.

503.12 Finished Surface. The cross-section of the patch shall be finished to match the existing cross-section of the roadway. Any existing rutting shall be continued for the first 3 m length in the direction of travel. A broomed texture, or tining as applicable, to match the existing concrete surface, is required. Surface variations greater than 3 mm in a 3 m interval along the longitudinal direction will render the work defective. Grinding is an acceptable patch-surface correction procedure.

503.13 Curing and Protecting. Curing shall conform to the requirements of Subsection 501.10. When a liquid membrane curing compound is used, it shall be applied uniformly, immediately upon completion of the patch texturing, at a rate of 0.3 L/m^2.

Immediately after Class A concrete has achieved initial set, the entire patch shall be covered with a layer of wet burlap, followed by a 100 µm polyethylene sheet and an approved insulating blanket, until the concrete has reached designed strength. The patched areas shall not be open to traffic until so permitted by the Engineer.

503.14 Opening To Traffic. The pavement shall be opened to traffic when directed, but shall not be opened in less than 72 hours after placing Class B concrete or until the concrete has achieved a minimum compressive strength of 15 MPa as determined by testing representative cylinders.

503.15 Continuously Reinforced Concrete Pavement. The Special Provisions, the applicable methods of Section 503, and the following requirements shall govern the patching of continuously reinforced concrete pavement.

The pavement shall be patched to preserve the continuity of the pavement. Repairs shall be made for the full width of the slab. If possible, patches shall be placed during stable weather conditions when the daily temperature variation is small. Patching shall be done as follows:

(a) The minimum length of patch shall be 3 m.

(b) The patch shall be placed on a 1 to 4 skew across the pavement to avoid both wheels of an axle crossing the construction joint simultaneously.

(c) A groove shall be cut 25 mm deep at each boundary of the patch without cutting the bar reinforcement.

(d) The Contractor shall saw two cuts parallel to and located 0.9 and 1.05 m respectively inside of each of the grooves which define the patch boundaries.

(e) The Contractor shall chip the concrete from between each pair of cuts down to the bar reinforcement and cut the bar reinforcement with a torch or bolt cutter.

(f) The Contractor shall remove all the concrete between patch boundaries with an air hammer, being careful not to unduly injure the stabilized foundation course, leaving 900 mm of bar reinforcement exposed at each end of the patch area.

(g) The Contractor shall repair the stabilized foundation course as prescribed in the Plans and Specifications.

(h) The Contractor shall splice deformed bars to each member of bar reinforcement which extends into the patch area from the ends of the existing pavement. The bar reinforcement shall be lapped 900 mm. The laps shall be secured with wire ties. Welding will not be permitted. If the bar reinforcement buckles, the Contractor shall correct just prior to placing concrete by removing and replacing the wire ties at the laps.

(i) The Contractor shall provide supplementary bars to increase the area of longitudinal steel by 50%. The splicebars and the supplementary bar reinforcement shall be firmly supported at the proper elevation above the foundation course by approved metal chairs.

(j) The Contractor shall place concrete in the patch area, using extreme care to consolidate so as to avoid honeycombing. This is particularly important because of the close spacing of the steel.

(k) The Contractor shall finish the surface of the patch to match the surface of the existing pavement. The patch shall be cured according to Subsection 501.10, and shall not be opened to traffic until the concrete has attained a compressive strength of 15 MPa.

503.16 Method of Measurement. The quantity of Portland cement concrete pavement patch will be measured as the actual number of square meters of concrete patch placed and accepted. The width for measurement will be the width from outside of the completed patches as constructed, measured parallel to the transverse saw cuts. The length will be the actual length measured parallel to the centerline of pavement. The thickness of the concrete patching will be the thickness specified on the Plans.

503.17 Basis of Payment. The quantity of Portland cement concrete pavement patch will be paid for at the Contract unit price per square meter. Price and payment will constitute full compensation for furnishing, hauling, and placing all materials, including high-early strength concrete; bar reinforcement, joint filler, and hot-poured joint sealant; for saw cutting, removing, and disposing of existing concrete; for preparing the foundation; for tooling, finishing, curing, sealing, and protecting the new concrete; for grinding the finished patch; for disposing of excess material; and for all labor, equipment, tools, and incidentals required to complete the work. In addition, the price and applicable payment(s) will be based on patches 4.8 m or less in length without bar reinforcement (Type I patch), and patches greater than 4.8 m in length with bar reinforcement (Type II patch).

Any damage caused by lift-out procedures will be at the Contractor’s expense.