

## SECTION 337

### PORTLAND CEMENT CONCRETE PAVEMENT

337.1 GENERAL: Portland cement concrete pavement shall consist of a mixture of portland cement, coarse and fine aggregate, class F fly ash, entrained air, and admixtures, placed and finished on either a prepared subgrade, or base in conformity with the lines, grades, depths and dimensions shown on the plans or as specified in the supplementary Specifications, and this specification. The CONTRACTOR shall be solely responsible for the portland cement concrete pavement construction supplied under this specification, materials, proportioning, placement, finish and curing. This work shall consist of constructing a pavement composed of portland cement concrete, in one course, with or without reinforcement as specified, in compliance with the specifications, lines, grades, depths, and typical cross sections shown on the plans or directed by the ENGINEER.

337.1.1 For construction and reconstruction street projects requiring pavement placement equal or greater than either 200 cy, concrete per day, the CONTRACTOR shall have a full time portland cement concrete construction supervisor on site to direct the pavement construction. The supervisor shall be certified as either an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of ENGINEERING Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010. The supervisor shall be identified by the CONTRACTOR at the prepaving conference and shall be the contact person for the ENGINEER during portland cement concrete pavement construction.

337.1.2 Pre-Paving Conference  
At the direction of the ENGINEER, a Pre-Paving Conference shall be held no later than seven calendar days prior to the start of pavement construction. The meeting agenda/assigned responsibilities shall be accomplished at the conference.

#### I. ENGINEER/OWNER

- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.
- C. Review CONTRACT requirements for pavement construction.
- D. Review Quality Assurance Program.

#### II. CONTRACTOR

- A. Review pavement construction schedules.  
Proposed pavement construction schedule for

duration of the project.

- B. Identify construction personnel and contact telephone numbers.

1. CONTRACTOR Staff
2. Sub-CONTRACTOR (s)
3. Supplier (s)
4. Safety Manger

- C. Present construction placement procedure plans.

1. Equipment Schedule
2. Portland Cement Concrete Design Mix
3. Paving methodology
4. Traffic Control Plan
5. Quality Control Plan

### III. DISCUSSION AND COMMENT

#### 337.2 REFERENCES:

337.2.1 American Society for Testing and Materials (Latest Edition) (ASTM):

- C31 Making & Curing of Concrete Test Specimens in the Field  
C39 Test for Compressive Strength of Cylindrical Concrete Specimens  
C94 Specification for Ready-Mixed Concrete

337.2.2 This Publication:

- SECTION 101 PORTLAND CEMENT CONCRETE  
SECTION 102 STEEL REINFORCEMENT  
SECTION 105 CONCRETE CURING COMPOUND  
SECTION 107 JOINT FILLER AND SEALANT MATERIAL  
SECTION 302 BASE COURSE  
SECTION 305 CEMENT TREATED BASE  
SECTION 307 PLANT MIX BITUMINOUS TREATED BASE  
SECTION 349 CONCRETE CURING

#### 337.3 MATERIALS:

337.3.1 The Portland cement concrete used in the pavement constructed under this section shall conform to the requirements of Section 101 or as specified by the plans and/or the Supplemental Technical Specifications.

337.3.2 Steel reinforcement used in the concrete constructed under this section shall conform to the requirements of Section 102 or as specified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings of

the steel reinforcement.

337.3.3 Expansion joint material, fillers, and sealants used on the concrete constructed under this section shall conform to the requirements of Section 107 or as specified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings, if required.

337.3.4 Liquid membrane forming compounds for curing concrete if used on the concrete constructed under this section shall conform to the requirements of Section 105 or as specified by the plans and/or Supplemental Technical Specifications.

#### 337.4 PROPORTIONING:

337.4.1 Proportioning of Portland cement concrete used in pavements shall be as specified in Section 101 and specified in the plans and/or Supplemental Technical Specifications. The specific proportioning shall be specified in the mix design submittal provided by the CONTRACTOR to the ENGINEER and the concrete supplied to the project.

337.4.2 (Empty)

#### 337.5 STRENGTH REQUIREMENTS:

337.5.1 Portland Cement Concrete Pavement shall comply with the requirements specified in the plans and/or specified in the Supplemental Technical Specification.

337.5.2 Portland cement concrete pavement may be opened to traffic after it has obtained 85% of the design strength specified or after 14 days, whichever comes first. The 85% of the design strength shall be verified in accordance with Section 101 by field cured concrete cylinders cured in the field the same as the concrete they represent.

#### 337.6 CONSTRUCTION EQUIPMENT:

337.6.1 GENERAL: Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the ENGINEER as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

#### 337.6.2 SLIP FORM PAVERS:

337.6.2.1 Machines for placing and finishing concrete pavement shall be mechanical self propelled and self leveling, of approved types and shall be capable of compacting and finishing concrete as required. Slip form pavers shall be

equipped with an adjustable template or reciprocating screed or screens arranged to strike off the pavement surface to the roadway crown or slope shown on the plans. The paver shall be equipped with vibratory assemblies, with or without tamping bars which operate over the full width of the surface being placed. When the forward motion of the paver is stopped, vibratory and tamping mechanisms shall also be stopped.

337.6.2.2 For pavers of the adjustable template type, with or without reciprocating screens, the vibratory assembly shall consist of internal spud type units spaced not more than 30 inches apart across the width of the paver under the leading edge of the fixed screed. Each vibratory unit shall be operated at a minimum rate of 7,000 impulses per minute.

337.6.3 CONCRETE SAW: The CONTRACTOR shall provide sawing equipment adequate in number of units and power to complete the sawing with a water cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required time and rate. The CONTRACTOR shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operation. The CONTRACTOR shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

337.6.4 FORMS: Straight side forms shall be made of a metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the specified, without horizontal joint, and a base width not less than 0.8 of the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 100 foot radius or less. Flexible or curved forms shall be of a design acceptable to the ENGINEER. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built up forms shall not be used except where the total area of pavement of any specified depth on the project is less than 100 cy. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.

337.6.5 JOINT SEALING APPLICATORS: Applicators for sealing materials shall be equipped with devices to mix, heat and apply joint sealers as required by the recommendations of the manufacturers of the material being used. Applicators shall be equipped with pressure type devices with adequate hose and a nozzle so that the specified shape factor may be constructed.

### 337.7 PREPARATION OF GRADE:

337.7.1 After the roadbed has been graded and compacted, the grade shall be trimmed to finish grade and cross section, extending the work at least 2 feet beyond each edge of the proposed concrete pavement.

337.7.2 The subgrade or aggregate base upon which the pavement is to be placed shall not vary more than  $\pm 0.10$  foot of the finish grade elevation and cross section specified prior to placing concrete. When cement or asphalt treated bases are used, finish grading shall be done at the time the base material is placed and shall be maintained to true section and grade until concrete placement is completed. The CONTRACTOR shall set reference lines, approved by the ENGINEER, parallel to the established grade as a means of grade control for subsequent finish grading operations.

### 337.8 SETTING FORMS:

337.8.1 BASE SUPPORT: The foundation under the forms shall comply with the requirements of Section 301, 302, 305, and 307 and the supplemental technical specifications, as applicable, so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with granular material in lifts of inch or less for a distance of 18 inches on each side of the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

337.8.2 FORM SETTING: Forms shall be set sufficiently in advance of the point where concrete is being placed to permit checking the forms for line and grade. After the forms have been set to correct elevations, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than 3 pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than +/- one inch at any point. No excessive

settlement or springing of forms under the finishing machine will be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

337.8.3 GRADE AND ALIGNMENT : The alignment and grade elevations of the forms shall be checked. and corrections made by the CONTRACTOR immediately before placing the concrete. When any form has been disturbed or any grade is found unstable, the form shall be reset and rechecked.

### 337.8.4 CONDITIONING OF SUBGRADE OR BASE COURSE:

337.8.4.1 When side forms have been securely set to grade the distance from top of form to top of subgrade or base course shall be checked in all areas to be not less than the specified pavement depth nor greater than the pavement depth plus 0.5 in, and brought to proper cross section. High areas shall be trimmed. Low areas may be filled and compacted to a condition similar to that of surrounding grade.

337.8.4.2 Unless treated base course material is specified, the subgrade or base course shall be maintained in the specified compaction moisture range when pavement is to be placed within 24 hours of completion of subgrade preparation or aggregate base course construction. If the time to pavement construction exceeds 24 hours, the prepared subgrade or aggregate base course shall be prime coated by the CONTRACTOR at no cost to the OWNER.

### 337.9 PLACING CONCRETE:

337.9.1 Concrete shall be placed on the prepared subgrade or aggregate base in uniform depth for the full width of the lane or area to be paved, without segregation, and to provide a minimum of redistribution. The placing of concrete in windrows or other methods which require excessive redistribution will be permitted for slip form pavement construction only. Placing concrete shall be continuous between transverse joints without the use of intermediate bulkheads.

337.9.2 When concrete pavement is to be placed adjoining newly constructed concrete pavement, the loading placed on the previously constructed pavement shall be limited to the following.

337.9.2.1 Light loading will be permitted 3 days after placement or when the pavement has reached 50% of its design strength, whichever comes first. Light loading is the placing and operating of the placement/finishing screed and other finishing

bridges,

337.9.2.2 Heavy loads will not be permitted until 14 days after placement or until the concrete has reached 85% of its design strength, whichever comes first. Heavy loads are vehicles of any size.

337.9.3 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, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.

337.9.4 Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

337.9.5 Should any concrete materials fall on or be worked into the surface of a completed slab, the material shall be removed immediately by approved methods.

337.10 TEST SPECIMENS: The CONTRACTOR shall furnish the concrete for casting cylinders and other required tests. Concrete testing shall comply with the requirements of SECTION 101, as directed by the ENGINEER. The ENGINEER or an independent testing laboratory designated by the ENGINEER shall fabricate and test specimens. Results shall be reported to the ENGINEER, CONTRACTOR, supplier of the concrete, and OWNER. Sampling and testing of smaller quantities of concrete used in minor paving work will be done as required by the ENGINEER.

### 337.11 JOINTS:

337.11.1 GENERAL: Joints shall be constructed of the type and dimensions, and at the locations required by the plans. Unless otherwise specified on the plans or approved by the ENGINEER, transverse and longitudinal contraction joints shall be constructed to the dimensions specified in the Contract Documents and at the locations shown on authorized joint plan prepared by the CONTRACTOR and authorized by the ENGINEER. Joints shall be complete from edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

### 337.11.2 LONGITUDINAL JOINTS:

337.11.2.1 When required, deformed steel tie bars and load transfer smooth dowel bars, of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints; they shall be placed by approved equipment or rigidly secured by chairs or other approved supports to prevent displacement during concrete placement and finishing. Deformed 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, steel side forms shall be used which will form a key way along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed or, in lieu of bent tie bars, approved two piece connectors may be used.

337.11.2.2 Longitudinal formed joints shall consist of a groove, or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the a depth of not less than one-third the depth of the associated pavement, by not greater than one-quarter inch width, and line specified in the authorized joint plan, while the concrete is in a plastic state. The groove, or cleft, shall be filled with either a premolded strip or an approved sealer. Joints shall be complete from edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

337.11.2.3 The longitudinal formed joint filler material shall be installed so that its ends are in contact with the transverse joints filler material, if any.

337.11.2.4 Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth of not less than one-third the depth of the associated pavement, by not greater than one-quarter inch width, and line specified in the authorized joint plan. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the authorized joint plans. The sawed area shall be thoroughly cleaned and cured immediately after sawing.

### 337.11.3 TRANSVERSE EXPANSION JOINTS:

337.11.3.1 The preformed expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form.

Preformed joint filler shall be furnished in lengths equal to the width of one traffic lane, except that when ramp or lane width is more than 12 feet, two pieces may be used provided the minimum length installed is six feet. Damaged or repaired joint filler shall not be used unless approved by the ENGINEER.

337.11.3.2 The preformed expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one half inch in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

#### 337.11.4 TRANSVERSE CONTRACTION JOINTS:

337.11.4.1 Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surfaces of the pavement, and, when shown on the plans, shall include load transfer assemblies. Joints shall be complete from and through edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

337.11.4.2 Preformed Transverse strip contraction joints shall be formed by installing a parting strip to be left in place. The strip shall form a groove or cleft to a depth not less than one third the depth of the pavement and not wider than one-fourth inch.

337.11.4.3 Formed groove contraction joints shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint. The groove shall be to a depth not less than one-third the depth of the pavement and not wider than one-fourth inch.

337.11.4.4 Sawed contraction joints shall be created by sawing grooves in the surface of the pavement of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be immediately cured. The saw cut shall be to a depth not less than one-third the depth of the pavement and not wider than one-fourth inch.

337.11.4.5 All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, a contraction joint groove shall be formed prior to initial set of concrete as provided in Subsections 337.11.4.2 or 337.11.4.3.

337.11.4.6 Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive joint edge raveling, before transverse shrinking cracks occur.

337.11.4.7 Transverse formed joints shall comply with the requirements of Subsection 337.11.2.2 for the longitudinal formed joints.

337.11.4.8 Transverse construction joints shall be constructed at specified transverse joint locations specified in the authorized joint plan when there is an interruption of more than 30 minutes in the concreting operation. No transverse joint shall be constructed within 10 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed by the ENGINEER.

#### 337.11.5 JOINT CURING:

337.11.5.1 All joints sawed in concrete pavement shall be cured after the removal of resulting dust or slurry in accordance with the following optional methods.

337.11.5.2 A strip of curing paper, polyethylene or other suitable moisture retention material, at least six inches in width, shall be centered over the joint, weighted down for its full length with soil, sand or other material to hold it in place.

337.11.5.3 A filler of paper, jute rope, or other suitable material shall be forced into the joint and sprayed with curing compound.

337.11.5.4 A tape, at least 2-1/2 inches wide, made from curing paper, polyethylene or other suitable moisture retention material and provided with

adhesive material near each edge which will seal the tape to the pavement, shall be centered over the joint, and at the slab edges extend the tape 2 inches below the saw cut.

337.11.5.5 The adhesive material shall be of a type which can readily be removed from the pavement upon completion of the curing.

337.11.5.6 Alternate or other methods for curing joints may be used when approved by ENGINEER. Methods shall satisfactorily prevent the escape of moisture from the concrete at the joint and leave no detrimental residue adhering to the pavement or joint surfaces. The CONTRACTOR shall clean joints of deleterious material by flushing with water, cleaning with air jets of adequate pressure, or by resawing, at his expense, prior to placing the sealing material.

337.11.5.7 Regardless of the type of materials or methods used curing joints, the material or methods selected shall be applied to the joint immediately after the joint is sawed and shall remain in place for a minimum of 48 hours after which the joint shall be cleaned and sealed, as provided in Subsection 337.17.

#### 337.11.6 LOAD TRANSFER DEVICES:

337.11.6.1 Dowels, when used, shall be held in position parallel to the surface and center line of the slab by a metal device that is left in the pavement. Dowels shall be located at the mid depth of a pavement slab, perpendicular and centered on the joint, aligned parallel to the longitudinal centerline of the pavement.

337.11.6.2 One-half the length of each dowel painted with one coat of lead or tar paint shall be thoroughly coated with asphalt MC 70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. An approved dowel cap or sleeve conforming to the requirements shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be water tight. The sleeved end of the dowel shall be lubricated as specified above.

337.11.6.3 In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the ENGINEER.

#### 337.12 FINISHING:

337.12.1 SEQUENCE: The sequence of finishing operations shall be strike off and consolidation, floating, straight edging, and final surface texturing.

The addition of water to the surface of the concrete to assist in finishing operations will not be permitted. The humidity above the fresh concrete surface may be allowed to be improved with a fine fog spray generated by means of approved fogging equipment.

#### 337.12.2 FINISHING AT JOINTS:

337.12.2.1 The concrete adjacent to formed joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.

337.12.2.2 After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints.

337.12.3 MACHINE FINISHING: Vibrators for full width vibration of concrete paving slabs shall meet the requirements in Subsection 337.6.2. If uniform and satisfactory density of concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the CONTRACTOR will be required to furnish equipment and methods which will produce pavement conforming to the specifications. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

#### 337.12.4 HAND FINISHING:

337.12.4.1 Hand finishing methods will not be permitted except under the following conditions:

337.12.4.2 In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when breakdown occurs. Hand tools shall have a length of not less than 3 feet and shall be floats or darbies only. Trowels, 'fresno's', and slicks shall not be used.

337.12.4.3 Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used.

337.12.4.4 The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape without deflection, and be constructed either of metal or of other

suitable material shod with metal. Prior to operating a hand screed, the screed shall be set on the forms and the distance from the bottom of the screed and the top of finish subgrade or base, full width of the formed pavement section, shall be checked to be at least equal to the depth of the pavement slab to be constructed and not greater than the sum of the depth of the pavement slab plus one-half inch. If a uniform cross section cannot be attained by the screed, it may not be used for the construction.

337.12.4.5 Consolidation shall be attained by the use of a suitable internal type vibrator or other approved equipment.

337.12.4.6 In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking surface is of uniform texture, true to grade and cross section, and free from porous areas. Vibratory and roller screeds shall be drawn forward in the vibrating and rolling off process. If necessary, this shall be repeated until the action mode. Transverse movement is not required for vibratory and roller screeds.

#### 337.12.5 FLOATING:

337.12.5.1 After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float, using one of the following methods as specified or permitted. A transverse and or longitudinal float shall be required for all pavement whether finishing is accomplished by hand methods, with a slip form machine or with fixed forms, except as hereinafter provided.

337.12.5.2 The requirements for floating may be waived for the slip form method of placement if it is successfully demonstrated that a satisfactory surface is being obtained by other means.

337.12.5.3 Hand Method: The hand operated transverse float shall be not less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping. The float shall be worked with a sawing motion transverse the slab from edge to edge. Movement ahead along the center line of the pavement shall be in successive advances of not more than one half of the length of the float.

337.12.5.4 Mechanical Method: The mechanical float shall be of a design approved by the ENGINEER, and shall be in good working condition. The tracks from which the float operates shall be

accurately adjusted to the required finish pavement surface profile. The forward speed shall be adjusted so that the float will lap the distance as directed by the ENGINEER. The float shall pass over each area of pavement until the surface is uniformly closed.

337.12.5.5 Alternative Mechanical Method: As an alternative to the mechanical method above, the CONTRACTOR may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels or tracks. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long handled float. Care shall be taken not to work the crown out of the pavement during the operation.

337.12.6 STRAIGHTEDGE TESTING AND SURFACE CORRECTION: After the floating has been completed, but while the concrete is still plastic, the surface of the concrete shall be trued with a 10 foot (3.0 m) straight edge. For this purpose the CONTRACTOR shall furnish and use an accurate 10 foot (3.0 m) straightedge. The straightedge shall be drawn transverse across the surface of the concrete pavement from edge to edge. Advance along the road shall be in successive stages of not more than  $\frac{1}{2}$  the length of a straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge truing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section. If a slip form paver is used, the maximum deviation from a true cross section within the area bounded by lines 6 inches from the edges of the pavement shall be  $\frac{1}{4}$  inch. Additional floating, edging and surface work, except texturing shall not be allowed after the surface has been trued with the straight edge.

337.12.7 FINAL FINISH: The final finish shall be one of the following:

337.12.7.1 The surface texture is to be a longitudinal drag finish except at intersections, and approaches and departures to intersections. A drag shall consist of a seamless strip of damp burlap, cotton fabric or other material approved by the ENGINEER, which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. The dimensions of the drag shall be such that a strip of burlap or fabric at

least 3 feet wide is in contact with the full width of the pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16 inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

337.12.7.2 The surface texture at intersections, and a minimum of 100 feet of approaches and departures to intersections shall be a transverse rake tine grove or similar finish as authorized by the ENGINEER. The grove shall be at one eighth to one quarter inch wide by one eighth to three sixteens inch deep. The groves shall be spaced not less than two times the grove width and not more than 6 times the grove width. A tine float shall not be used. Transverse tine grooving of the highest traffic street shall be carried through the intersection.

#### 337.12.8 EDGING AT FORMS AND JOINTS:

337.12.8.1 Edging shall be completed prior to straight edge truing of the surface, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans. A well defined and continuous radius shall be "produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

337.12.8.2 At all joints, all tool marks appearing on the slab adjacent to the joints shall be eliminated by texturing. The rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

337.12.8.3 All joints shall be trued with a straightedge bisected by and drawn parallel to the joint before the concrete has set, and correction made if one side of the joint is higher than the other, or if they are higher or lower than the adjacent slabs. The joint shall be straight edge trued after correction and prior to texturing.

#### 337.13 CONCRETE PAVEMENT SLIP FORM METHOD:

337.13.1 GENERAL: Pavement may be constructed without the use of fixed forms by the slip form method as authorized by the ENGINEER.

337.13.2 GRADE: After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of a properly designed machine. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. The grade should be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

337.13.3 ALIGNMENT: The horizontal alignment of full width slabs shall not deviate from the line shown on the plans or established by the ENGINEER by more than one half (1/2) inch at any point.

337.13.4 PLACING CONCRETE: The concrete shall be placed with an approved slip form paver designed to spread, consolidate, screed, and float finish the freshly placed concrete in one complete pass of the machine or machines in such manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The concrete shall be held at a uniform consistency, having a slump which lies within the range of 1 to 2 1/2 inches. The slip form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

337.13.5 FINISHING: The surface smoothness and texture shall meet the requirements of Subsection 337.12.7.

#### 337.14 SURFACE TEST:

337.14.1 The pavement surface shall be tested with a 10 foot straightedge or other device approved by the ENGINEER. Areas showing high spots of more than 1/8 inch but not exceeding 1/2 inch in 10 feet



shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show deviations in excess of 1/8 inch when tested with a 10 foot straightedge. Where the departure from correct cross section exceeds ½ inch, or where irregularities in the finished surface of the pavement vary more than ½ inch above or ½ inch below the grade elevation established by the ENGINEER, the pavement shall be removed and replaced by the CONTRACTOR at no expense to the OWNER.

337.14.2 Any area or section so removed shall be removed as a panel from transverse joint to transverse joint, the full width of the lane involved.

337.15 CURING: Immediately after the finishing operations have been completed the CONTRACTOR shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the ENGINEER.

337.16 REMOVING FORMS: Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has been set for at least 12 hours, except auxiliary form used temporarily in widening areas. Forms shall be removed carefully so as to avoid damage to pavement. After the forms have been removed, the sides of the slabs shall be cured as outlined in Section 349. Honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall be removed as a panel from transverse joint to transverse joint, the full width of the lane involved.

#### 337.17 SEALING JOINTS:

337.17.1 Joints shall be filled with joint sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.

337.17.2 The sealing material shall be applied to each joint opening to conform to the details shown on the plans and the manufacturer's recommendation for the authorized sealant. The placing shall be done in such a manner that the material will not be spilled on the driving surfaces of the concrete. Any excess material on the driving 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. Joint sealing material shall not be placed when the air temperature in the shade is less than 50°F., unless approved in writing by the ENGINEER. A backer rod or form shall be used and placed at the

specified depth as the bottom form for the sealant. The backer rod shall be compatible with the sealant material and maintain its shape and cross section after placement of sealant.

337.17.3 The joint sealant detail shall be used at all sawed/embedded traffic control devices. The joints and sealants shall be constructed as specified.

#### 337.18 PROTECTION OF PAVEMENT:

337.18.1 The CONTRACTOR shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This include watchmen and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc.

337.18.2 Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement replaced by the CONTRACTOR at no expense to the OWNER, as directed by the ENGINEER.

337.19 OPENING TO TRAFFIC: The pavement will not be opened to traffic until the pavement has met the strength requirements of Subsection 337.5. The pavement shall be cleaned of all loose material and debris, striped for traffic control prior to opening to traffic.

337.20 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. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

337.21 DISCONTINUE PAVING OPERATIONS: When the surface finish of completed pavement is not in accordance with Subsection 337.14 or an excessive number of surface irregularities are detected when the completed pavement is tested in accordance with Subsection 337.14, or the edge of the pavement slumps more than 1/4 inch below the established cross section, or other recurring defects are apparent on successive working days, paving operations shall be discontinued as directed by the ENGINEER. Suitable equipment and methods shall be provided by the CONTRACTOR to correct the deficiencies at no cost to the OWNER.

337.22 TOLERANCE IN PAVEMENT THICKNESS:  
337.22.1 Full depth cores shall be drilled by the

CONTRACTOR and submitted to the ENGINEER, in pavement to verify constructed pavement depth. Cores shall be drilled at not less than two nor more than four locations for each Lot, 100 cy, as directed by ENGINEER. Pavement depth for a lot will be the average of the cores taken in the Lot. The depth of the pavement at a core location shall be the average of four measurements of the homogeneous length of the core taken at right angles around the core circumference, as directed by the ENGINEER. The CONTRACTOR shall patch the core holes with the authorized design mix placed in the surrounding pavement.

337.22.2 Where the structural strength of the concrete is seriously affected by the deficiency in thickness, the ENGINEER may order the removal and replacement of the work so affected at no additional expense to the OWNER.

### 337.23 STRENGTH TEST REQUIREMENTS

Minimum strengths which must be achieved for acceptance are those set forth in Subsection 337.5, STRENGTH REQUIREMENTS.

337.24.1 MEASUREMENT: Portland cement concrete pavement shall be measured by the square yard per each thickness specified on the plans and in the bid proposal.

337.24.2 PAYMENT: The payment for Portland Cement Concrete Pavement shall be at the adjusted contract unit price per square yard for each pavement thickness specified, complete in place, adjusted in accordance with the following equation, and this specification, as authorized by the ENGINEER. Payment shall include all material, equipment and labor required in placing, finishing, curing, backfilling and cleanup.

$$UP' = PF_M \times PF_D \times UP$$

UP', adjusted contract unit price

UP, contract unit price

PF<sub>M</sub>, material price adjustment,  
see SECTION 101.16.2

PF<sub>D</sub>, see 327.24.3

337.24.3 The depth factor, PF<sub>D</sub>, shall be defined in accordance with TABLE 337.24..3.A, based on the average of a minimum 3 full depth cores taken in each lot of 1000 cy, as directed by the ENGINEER. The depth of the pavement at a core location shall be the average of three measurements of the

homogeneous length of the core taken at right angles around the core circumference, as directed by the ENGINEER.

TABLE 337.24.1 DEPTH FACTOR, PF<sub>D</sub>

Deficient Pavement Depth, D-d					PF <sub>D</sub>
0	$\leq$	D-d	$\leq$	0.25 in	1.00
0.25 in	<	D-d	$\leq$	0.50 in	$(d)^2 / (D)^2$
0.50 in	<	D-d	$\leq$	1.00 in	[A] or [B], [C]
		D-d	>	1.00 in	[A]
Excessive Pavement Depth, D-d					PF <sub>D</sub>
0	<	d-D	$\leq$	1.00 in	1.00
		d-D	>	1.00 in	[E] or [F]

#### NOTES:

- d, average depth of the pavement structure of a Lot as determined by field cores.
- D, specified depth for the pavement structure of a Lot.
- A. Remove and replace at no cost to the OWNER, as directed by the ENGINEER.
- B. If determined by the ENGINEER to be more practical to accept the pavement, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor.  $PF_D = (d)^2 / (D)^2$ , for LOT(s), as directed by the ENGINEER.
- C. No single core height less than the specified depth less 1.25 in.
- E. Remove and replace at no cost to the OWNER, if excessive uncontrolled cracking is observed, as directed by the ENGINEER.
- F. If determined by the ENGINEER to be more practical to accept the pavement, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor of  $PF_D = 1.00$ , as directed by the ENGINEER.