Amend **Section 411 - Portland Cement Concrete Pavement** to read as follows:

"SECTION 411 - PORTLAND CEMENT CONCRETE PAVEMENT

411.01 Description. This section is for constructing pavement composed of portland cement concrete (PCC) with or without reinforcement, on a prepared subgrade or base course according to the contract or as specified by the Engineer.

At the option of the Contractor, the Contractor may construct the pavement with equipment using stationary side forms or slip form paving.

411.02 Materials. Concrete shall have a minimum flexural strength, f'_r of 650 psi and shall conform to Section 601 - Structural Concrete. Other materials shall conform to:

Joint Filler	705.01
Joint Sealer	705.04
Reinforcing Steel	709.01
Curing Materials	711.01

411.03 Construction Requirements.

(A) Proportioning. Base the proportioning on the predetermined cement content or designed for minimum flexural strength as specified in the contract. Submit the proportions of the materials for acceptance by the Engineer.

Determine the slump according to AASHTO T 119 (ASTM C 143) and air content according to AASHTO T 152 (ASTM C 231). Make, cure, and test the test specimens according to AASHTO T 23 (ASTM C 31), AASHTO T 22 (ASTM C 39) and AASHTO T 97 (ASTM C 78), and the cement content according to AASHTO T 121 (ASTM C 138).

State the proportions in terms of aggregates in a saturated surface-dry condition. Adjust the batch weights periodically to take into account the actual moisture of the aggregates at the time of use. The designated proportions govern during the progress of the work except in the following:

(1) Do not make changes in the sources or character of the materials without due notice to the Engineer. Do not use the new materials until the Engineer designates and accepts the new proportions based upon laboratory tests and trial mixes.

(2) When concrete having the required consistency cannot be produced without exceeding the maximum allowable water-cement

ratio specified, increase the cement content as specified by the Engineer.

(3) When concrete of the desired plasticity and workability cannot be obtained with the proportions originally accepted, the Engineer will make such changes in aggregate weights as required provided the original designated cement content does not change except as specified in items (1) and (2) above.

(B) Equipment. The Engineer will examine the equipment and tools necessary for handling materials and doing the work for acceptance as to the design, capacity, and mechanical condition. The equipment shall be at the work site sufficiently ahead of the start of this activity for examination. The Contractor shall comply with the following:

(1) Batching Plant and Mixers. The batching plant and mixers shall conform to Section 601 - Structural Concrete.

(2) Hauling Equipment. Equipment for hauling concrete shall conform to Section 601 - Structural Concrete.

(3) Finishing Equipment.

(a) Finishing Machine. The finishing machine shall be self-propelled. When in operation, equip the finishing machine with at least two oscillating type transverse screeds supported by the forms. The finishing machine shall handle and finish the mixes required for this type of construction. The finishing machine shall not displace the reinforcement, side forms, or joints.

(b) Vibrators. Vibrators, for full width vibration of the concrete, may be either the surface pan type or the internal type with immersed tube or multiple spuds. The vibrators may be attached to the spreader or the finishing machine or mounted on a separate carriage. The vibrators shall not come in contact with the reinforcement, load transfer devices, subgrade, or side forms. Operate the vibrating equipment according to the manufacturer's recommended frequency. However, the frequency of the surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute. Hand vibrators shall have a frequency of not less than 5,000 impulses per minute. Furnish a tachometer for measuring and indicating the frequency of vibration.

(c) Machine Floats. Mechanical floats shall be self-propelled. Use mechanical floats designed to finish pavement smoothly and true to grade. Mechanical floats shall run either on side forms or on adjacent lanes of concrete.

Use floats constructed of hardwood, steel, or steel-shod and equipped with devices to permit adjusting the underside of a true flat surface.

(d) Slip-Form Pavers. Slip-form pavers shall be self-propelled. Use slip-form pavers equipped with traveling side forms of sufficient dimensions, shape, and strength to produce pavement of the required cross section. Slip-form paving equipment shall spread, consolidate and screed freshly placed concrete so a minimum of handwork is required to produce a dense homogeneous pavement true to the cross section and profile within the specified tolerances.

Use slip-form pavers equipped with high frequency internal vibrators for the full width. The vibrators may be mounted with their axis parallel or normal to pavement alignment. When mounting the vibrators with their axis parallel with the pavement alignment, space the vibrators at an interval not to exceed 2.5 feet measured center to center.

When mounting vibrators with their axis normal to the pavement alignment, space the vibrators so that the lateral clearance between individual vibrating units does not exceed 0.5 feet.

Use slip-form pavers designed so that the longitudinal axis at the center of each vibrating unit is not more than 0.5 feet above the pavement grade while spreading, compacting, and shaping the pavement.

The vibration rate of each vibrating unit shall be not less than 5000 cycles per minute. Furnish a tachometer to measure the frequency of vibration.

The Contractor may use the equipment designed to complete the paving operations with one machine or may consist of a mechanical spreader followed by a separator power unit.

(4) Concrete Saw. When sawing joints are elected or specified, 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 rate. Provide at least one standby saw in good working order. Maintain an ample supply of saw blades at the work site during sawing operations. Provide adequate artificial lighting facilities for night sawing. This equipment shall be on the work site both before and continuously during concrete placement.

(5) Forms. Use straight side forms made of a metal having a thickness of not less than 7/32 inch, furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete and a base width equal to at least 80 percent of the specified pavement thickness. The Engineer will not allow horizontal joint unless accepted by the Engineer as a built-up form. Each form section shall be straight and free from bends and warps. No section shall show a variation greater than 1/8 inch in 10 feet from the true plane on the top and 1/4 inch in 10 feet along the face of the form. The method of connecting form sections shall insure tight, neat joint. Side forms shall be of sufficient rigidity in the form and in the interlocking connection with adjoining forms such that springing will not occur under the weight of the subgrading and paving equipment or from pressure of concrete. The Contractor may use built-up metal forms by rigidly attaching a wood or metal section of suitable width and thickness to the bottom of the form providing an increase in depth of not more than 20%.

Use the flexible or curved forms of proper radius for curves of 100-foot radius or less. The Contractor may use the straight steel forms in sections of 10 feet or less in length for form lines having a radius greater than 200 feet. The Engineer will permit special forms of wood or steel for curved form lines having a radius of 200 feet or less. Where the use of standard pavement forms are impracticable, submit working drawings for acceptance. Five feet long straight steel form section will be acceptable for curved form lines having a radius of not less than 100 feet.

Forms shall be of sufficient rigidity to prevent distortion in edge alignment due to pressure of concrete. Do not use the wood forms as a track for operating paving and finishing equipment.

(C) Preparation of Grade. After grading and compacting the roadbed, trim the grade to the approximate correct elevation, extending

the work at least two feet beyond each edge of the proposed concrete pavement.

Grade and maintain the track path in a smooth compacted condition until after constructing the pavement.

(D) Setting Forms.

(1) Base Support. The foundation under the forms shall be hard and true to grade so that the form, when set, shall be firmly in contact for its whole length and at the specified grade. Fill the grades found below established grade with granular material in lifts of 0.5 inch or less for a distance of 18 inches on each side of the base of the form, and thoroughly compacted. Correct the above grade imperfections or variations by tamping or trimming as necessary.

(2) Form Setting. Set the forms sufficiently ahead of concrete placement to provide time to check the line and grade and provide a continuous concrete placement operation. After setting the forms to the correct grade, tamp the grade thoroughly, mechanically or by hand, at both the inside and outside edges of the base of the forms. Stake the forms into place with not less than three pins for each 10-foot section. Place a pin at each side of every joint. Lock the form sections tightly from play or movements. The forms shall not deviate from true line by more than 1/4 inch. Set the forms so that the forms will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Clean and coat the forms with a form release agent or oiled before placing the concrete.

(3) Grade and Alignment. Check and correct the alignment and grade elevations of the forms immediately before placing the concrete. When the forms are disturbed or grades become unstable, reset and recheck the forms.

(E) Conditioning of Subgrade or Base Course. Bring the subgrade or base course to proper cross section. Trim the high areas to proper elevation. The low areas may be filled and compacted to a condition similar to that of surrounding grade, or fill the low areas with concrete integral with the pavement. Maintain the finished grade in a smooth and compacted condition until placing the pavement.

If waterproof subgrade or base course cover material is not specified, moisten the subgrade or base course uniformly and remove excess water standing in pools or flowing on the surface before placing the concrete.

(F) Handling, Measuring, and Batching Materials. Handling, measuring, and batching materials shall be according to Section 601 - Structural Concrete.

(G) Mixing Concrete. Mixing concrete shall be according to Section 601 - Structural Concrete.

(H) Limitations of Mixing. Do not mix, place, or finish the concrete when the natural light is insufficient, unless an adequate and acceptable artificial lighting system is operated.

Before placing concrete pavement, have a good and sufficient supply of water available throughout the work. An inadequate water supply will be cause for delaying or shutting down the concrete mixer. In case of a deficiency of water, use the water available for curing the concrete already placed.

Make advance arrangements to prevent delay in delivery and placing of the concrete. An interval of more than 30 minutes between placing of two consecutive batches or loads of concrete shall constitute cause for stopping paving operations. When suspending concrete operations for such cause, make a joint at the location and of the type specified by the Engineer in the concrete already placed and according to Subsection 411.03(L) - Joints at no cost to the State.

(I) Placing Concrete. Make adequate advance arrangements for preventing delay in delivery and placing of the concrete. An interval of more than 45 minutes between placing of any two consecutive batches or loads shall constitute cause for stopping paving operations. When stopping paving operations, make a construction joint at the location and of the type specified by the Engineer at no cost to the State.

Slip-form paving and finishing machines shall be in satisfactory adjustment and operational condition. Before placing concrete, demonstrate proper adjustment of the screeds and floats on slip-form pavers by measurements from grade stakes driven to known elevations. Demonstrate satisfactory operation and adjustments of the propulsion and control equipment, including pre-erected grade and alignment lines by moving the slip-form pavers and finishing machines over a 500-foot length of prepared subgrade with the propulsion and control equipment fully operational.

Either construct the pavement in 12-foot widths separated by longitudinal weakened joints or monolithically in multiples of 12-foot widths with a longitudinal weakened plane joint at each traffic lane line.

Place the concrete while fresh. Do not use water for re-tempering concrete. Deposit the concrete on grade so as to require as little rehandling as possible. Unless truck mixers, truck agitators, or

non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, unload the concrete into an accepted spreading device and mechanically spread on the grade so as to prevent segregation of the materials. Placing shall be continuous between transverse joints without use of intermediate bulkheads. Use shovels for hand spreading, not rakes. Do not allow the workers to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Do not use concrete showing improper proportions of materials, including water, in the pavement. Remove and dispose such unsatisfactory concrete at no cost to the State.

Spread, shape, and consolidate the concrete so that the completed pavement will conform to the thickness and cross section requirements of the contract. The sides of pavement may be constructed on a batter not to exceed one horizontal to six vertical (1H:6V), provided the top of the pavement is maintained at the specified width.

When constructing portland cement concrete pavement adjacent to an existing parallel concrete pavement not constructed as part of the contract, spread, compact, and shape the concrete so that:

(1) the completed pavement will conform to the thickness and cross section requirements of the contract;

(2) the water does not pond on either side of the longitudinal joint with the existing pavement;

(3) the new pavement surface at the longitudinal joint conforms as close as possible to the elevation of the existing concrete pavement. Eliminate any differences in elevation between the new pavement and the existing pavement by finishing the new pavement within one foot of the existing pavement by hand methods, adding or removing concrete as necessary;

(4) the transverse straightedge, longitudinal straightedge, and Profile Index requirements specified in Subsection 411.03(M) - Final Strike-Off, Consolidation and Subsection 411.03(N) - Surface Test will not apply to the pavement surface within one foot of the existing concrete pavement;

(5) the profiles of the completed pavement surface specified in Subsection 411.03(N) - Surface Test are not required within four feet of the longitudinal construction joint with the existing concrete pavement;

(6) the thickness measurements specified in Subsection 411.03(T) - Tolerance in Pavement Thickness are not made in pavement within one foot of the existing concrete pavement; and

(7) the transverse weakened plane joints are constructed in pavement widening to match the spacing and skew of the weakened plane joints in the existing pavement.

When placing concrete adjacent to a previously constructed lane of pavement, do not operate the mechanical equipment on the existing lane of pavement until the existing concrete pavement has obtained a strength of not less than 550 pounds per square inch when tested according to AASHTO T 97 - Flexural Strength of Concrete (using Simple Beam with Three Point Loading).

Construct the pavement using only that paving equipment that produces a finished surface meeting straightedge and profile index according to Subsection 411.03(M) - Final Strike-Off, Consolidation, and Finishing and Subsection 411.03(N) - Surface Test. Failure of equipment to produce pavement that conforms to said requirements will constitute cause for stopping placement of concrete until the deficiency or malfunction is corrected.

When placing concrete adjacent to an existing pavement, equip that part of the equipment supported on existing pavement with protective pads on crawler tracks or rubber tired wheels with the bearing surface offset to run a sufficient distance from the pavement edge to avoid breaking or cracking that edge.

Spreading, compacting, and shaping shall also conform to:

(1) **Stationary Side Form Construction.** Spread, shape, and consolidate the concrete by one or more machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement conforms to required cross section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to finish the work required at a rate equal to that of concrete delivery.

Effectively consolidate the concrete for the full paving width by means of surface or internal vibrators.

When using vibrators to consolidate concrete, the rate of vibration shall not be less 3,500 cycles per minute for surface vibrators and shall not be less than 5,000 cycles per minute for internal vibrators.

Amplitude of vibration shall be sufficient to be perceptive on the surface of concrete more than one foot from the vibrating element. Furnish a tachometer for measuring and indicating frequency of vibration.

Vibrators shall not rest on new pavement or side forms. Connect the power to vibrators so that vibration ceases when forward or backward motion of the machine is stopped.

Spread and shape the concrete for exit ramp termini, truck weigh stations, ramps and connectors with steep grades and high rates of superelevation, short sections of City and County streets and roads, and concrete required to be placed in short lengths or in widths other than multiples of 12-foot traffic lanes by acceptable powered finishing machines supplemented by hand work as necessary. Consolidation of such concrete shall be by high-frequency internal vibrators within 15 minutes after depositing the concrete on the subgrade. Vibrate with care so to assure adequate consolidation adjacent to forms and uniformly across the full paving width. The Engineer will not permit use of vibrators for extensive shifting of the mass of concrete. Discontinue the methods of spreading, shaping, and compacting that result in segregation, voids, or rock pockets. Adopt methods that will produce dense homogeneous pavement conforming to required cross section.

(2) Slip Form Construction. Slip form paving equipment shall spread, consolidate, and screed freshly placed concrete so that a minimum of handwork is required to produce a dense homogeneous pavement true to cross section and profile. The Engineer will not permit abrupt changes in longitudinal deviation of the pavement. The horizontal deviation shall not exceed 1/10 of a foot from the alignment established by the contract.

Effectively consolidate the concrete for the full paving width by high frequency vibrators. Operate the slip-form paver with as nearly a continuous forward movement as possible. Coordinate the operations of mixing, delivering, and spreading the concrete to provide a uniform progress with stopping and starting of the paver held to a minimum. When stopping the forward movement of the paver, the vibratory and tamping elements shall also cease immediately. Do not apply tractive force to the machine except those tractive force controlled by the machine.

(J) Test Specimens. Furnish the concrete necessary for casting test beams and cylinders at no cost to the State. Cure the beams as specified for pavement according to AASHTO T 23 (ASTM C 31).

(K) Strike-Off of Concrete and Placement of Reinforcement. After placing the concrete, strike off the concrete to conform to the cross section shown in the contract and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown in the contract.

When placing reinforced pavement in two layers, strike off the entire width of the bottom layer to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in final position without further manipulation.

Place the reinforcement directly upon the concrete, place, strike off, and screed the top layer of the concrete. Remove and replace the portions of the bottom layer of concrete at no cost to the State when more than 30 minutes have elapsed after placement without covering the bottom layer with freshly mixed concrete.

When placing reinforced concrete in one layer, the reinforcement may be positioned ahead of concrete placement or may be placed in plastic concrete, after spreading by mechanical or vibratory means.

For the reinforcing steel, Subsection 602.04 - Storage, Surface Condition and Protection of Reinforcement, shall apply.

(L) Joints. Construct the joints normal to the pavement surface of the type, dimensions, and at locations required by the contract.

(1) Longitudinal Joints. The width of the joint shall be as required with a depth of d = t/4 where:

d = minimum depth rounded up to the nearest 0.01-foot

t = thickness of pavement in each lane

When paving lanes are poured separately and a sawed longitudinal joint is required, the longitudinal joints shall be as required by the contract.

Place the deformed steel tie bars of the specified length, size, spacing and material perpendicular to the longitudinal joint at a target depth of d = t/2. Place the deformed steel tie bars by mechanical equipment or secure the deformed steel tie bars rigidly by chairs or other supports to prevent displacement. Use 30 inches long No. 5 rebars and space 30 inches center to center. Tie bars which are to be bent and later straightened shall be grade 40. The Engineer may require other sizes, grades, lengths, and spacing base on slab width, thickness and the type of underlying

base. Do not paint or coat the tie bars with asphalt or other material not enclosed in tubes or sleeves.

(a) Longitudinal Construction Joints. When constructing adjacent paving lanes separately, the tie bars may be bent with keyways at right angles against the forms of the first lane constructed and straightened into final position before placing concrete in the adjacent lane or an acceptable two-piece tie bar connectors may be used. When inserting a two-piece tie bar connector mechanically during slip form paving, maintain the proper alignment and adequate bond with the plastic concrete.

(b) Sawed Joint. Complete the sawing of longitudinal joints within 12 hours of paving and before concrete is placed in subsequent adjacent lanes and before equipments or vehicles are allowed on the pavement.

(2) Transverse Expansion Joints. The expansion joint filler shall be continuous from form to form. Shape the expansion joint to the subgrade and to the keyway, if any, along the form. Furnish the preformed joint filler in lengths equal to the pavement width or equal to the width of one lane. Do not use damaged or repaired joint filler.

Hold the expansion joint filler in a vertical position to secure the preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than 0.25 inch in the horizontal alignment from a straight line. When assembling joint fillers in sections, do not use the offsets between units. The Engineer will not permit plugs of concrete anywhere within the expansion space.

(3) Transverse Contraction Joints. Transverse contraction joints include planes of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the plans, shall include load transfer assemblies.

(a) Formed Joints. The Contractor may use the formed joints made by depressing a tool or device into the plastic concrete, regardless whether the joints are to remain in or removed from the finished pavement, only with the written acceptance of the Engineer.

(b) Sawed Joints. Saw contraction joints by cutting grooves in the pavement with an acceptable power saw.

The width shall be the minimum width possible with the type of saw being used not exceeding 1/4 inch.

After sawing each joint, clean the sawed cut and adjacent concrete surface thoroughly.

The Engineer will designate the first joint immediately after separation or transverse contact joint and every second planned transverse contraction joint as control joints. Saw them from 4 to 12 hours after placing the concrete. The Engineer will determine the exact time of sawing. If necessary and regardless of weather conditions, continue the sawing operations day and night. Complete the sawing of transverse contraction joints before placing the concrete in adjacent lanes and before permitting traffic on the pavement.

In succeeding lanes of concrete pavement, saw the transverse joints within 24 hours after pouring the concrete. The Engineer will determine the exact time. Omit not more than three consecutive planned transverse contraction joints.

Saw the remaining transverse contraction joints after 24 hours. Complete the transverse contraction joints before pouring the concrete in adjacent lanes and before permitting traffic on the pavement.

When a crack occurs within 5 feet of a planned transverse contraction joint, omit sawing of that joint. Discontinue sawing when a crack develops in front of the saw. The Engineer will not pay for the joints sawed in violation of these provisions.

When curing the pavement by curing seal, restore the portions of the seal that are disturbed by sawing operations by spraying the area with additional curing seal.

(c) Transverse Construction Joints. Construct a transverse construction joint when an interruption of more than 30 minutes in the concrete operations occurs. Do not construct the transverse joint within 10 feet of any expansion joint, contraction joint, or plane of weakness. When the Contractor has not mixed sufficient concrete at the time of interruption to form a slab at least 10 feet long, remove and dispose of any excess concrete back to the last preceding joint as specified by the Engineer at no cost to the State.

(4) Load Transfer Devices. Install the load transfer units, when required, at transverse joints. The load transfer units include dowel bars of a grade and size required by the contract spaced on one foot centers and held in position with a wire basket or mechanically implanted. Place the dowels at a depth of d = t/2 where:

d = minimum depth rounded up to the nearest 0.01 foot

t = thickness of pavement of each lane

Place the dowels at this depth in the pavement parallel to the surface and pavement edge with a tolerance for such alignment of ± 1/4 inch per dowel. Vibrate the concrete around dowel bars without disrupting the alignment of the load transfer devices. Demonstrate that the method of dowel placement will have the bars in the proper location after the paving train has made its final pass over the joint.

Mark the center of the dowel assembly properly on both sides of the pavement slab for reference in forming or sawing the contraction joint.

Use wire baskets that remain in the pavement to hold the dowels and preformed material for load transfer units. Furnish a metal dowel cap or sleeve on each dowel bar to accommodate the expansion. Equip the cap with a stop to prevent closing during pavement operation. Maintain a clearance of one inch between the closed end of the cap and the end of the dowel to accommodate future movement of the concrete slab.

(M) Final Strike-Off, Consolidation and Finishing.

(1) Sequence. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging, and final surface finish.

In general, the Engineer will not permit the application of additional water to the surface of the concrete to assist in finishing operations. When permitting the application of water to the surface apply the water as a fog spray by an acceptable spray equipment.

(2) Finishing at Joints. Compact or firmly place the concrete adjacent to joints without voids or segregation against the joint material, under and around load transfer devices, joint assembly units, and other features designed to extend into the pavement.

Vibrate the concrete adjacent to joints mechanically as required in Subsection 411.03(I) - Placing Concrete.

After placing and vibrating the concrete adjacent to the joint as required in Subsection 411.03(I) - Placing Concrete, bring the finishing machine forward, operating to avoid damage or misalignment of the joints. When operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete and damage to or misalignment of the joints, stop the finishing machine when the front screed is approximately 8 inches from the joint. Remove the segregated concrete from in front of and off the joint; lift the front screed and set directly on top of the joint; and resume the forward motion of the finishing machine. When the second screed is close enough to permit the excess mortar in front of the screed to flow over the joint, lift the screed and carry it over the joint. Thereafter, the Contractor may run the finishing machine over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

(3) Machine Finishing.

(a) Nonvibratory Method. Distribute or spread the concrete as soon as placed. Soon after placing the concrete, strike off and screed the concrete by a finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture. Avoid excessive operation over a given area. Keep the tops of the forms clean by an effective device attached to the machine and maintain the travel of the machine on the forms true without lift, wobbling, or other variation tending to affect the precision finish.

During the first pass of the finishing machine, maintain the a uniform ridge of concrete ahead of the front screed for its entire length.

(b) Vibratory Method. Vibrators for full width vibration of concrete paving slabs shall conform to Subsection 411.03(B)(3)(b) - Vibrators. When uniform and satisfactory density of the concrete is not obtained by the vibratory method, furnish equipment and methods that produce pavement conforming to the contract. The provisions in Subsection 411.03(M)(3)(a) - Nonvibratory Method, not in conflict with the provisions for the vibratory method shall govern.

(4) Nonvibratory Method, Hand Finishing. The Engineer will not permit hand finishing methods except the following:

(a) When the mechanical equipment breaks down, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs, or

(b) Where operations of the mechanical equipment is impractical such as narrow widths or areas of irregular dimensions, hand methods may be used to finish the concrete.

Strike off and screed the concrete, as soon as placed. Provide a second screed to strike-off the bottom layer of concrete if reinforcement is used.

The screed for the surface shall be at least two feet longer than the maximum width of the slab to be struck off. The screed shall be an acceptable design and sufficiently rigid to retain its shape. Use a screed constructed either of metal or of other suitable material shod with metal.

Attain consolidation by using a vibrator.

In operation, move the screed 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 strike-off process. When necessary, repeat this operation until the surface is of uniform texture, true to grade and cross section and free from porous areas.

(5) Floating. After striking off and consolidating the concrete, smooth, true, and consolidate the concrete further by a longitudinal float, using one of the following methods:

(a) Hand Method. The hand-operated longitudinal float shall not be less than 12 feet in length and 6 inches in width, stiffened properly to prevent the float from flexing and warping. Work the longitudinal float with a sawing motion while the float is held in a floating position parallel to the road centerline and passing gradually from one side of the pavement to the other. Operate the float from the foot bridges, rest on the side forms, and span without touching the concrete.

Movement ahead along the centerline of the pavement shall be in successive advances of not more than 1/2 the length of the float. Waste excess water or soupy material over the side forms on each pass.

(b) Mechanical Method. Adjust the tracks and float accurately to the required crown. Coordinate the float with the adjustments of the transverse finishing machine so that a small quantity of mortar is carried ahead of the float. Adjust the forward speed so that the float laps the distance specified on each transverse trip. The float shall pass over each area of pavement at least two times. The Engineer will not permit excessive operation over a given area. Waste the excess water or soupy material over the side forms on each pass.

(c) Alternate Mechanical Method. As an alternative to Subsection 411.03(M)(5)(b) - Mechanical Method, a machine composed of a cutting and smoothing float or floats, suspended from and guided by a rigid frame may be used. Use a frame that is carried by four or more visible wheels riding on and constantly in contact with the side forms.

When necessary, the long-handled floats may be used to smooth and fill in open-textured areas in the pavement. The floats shall have blades not less than five feet in length and 6 inches in width. Do not use the long-handled floats to float the entire surface of the pavement in lieu of, one of the preceding methods of floating.

When striking-off and consolidating by the hand method and the crown of the pavement does not permit the use of the longitudinal float, float the surface transversely by the long-handled float. Do not work the crown out of the pavement during the operation. After floating, remove the excess water and laitance from the surface of the pavement by a straightedge 10 feet or more in length. Lap the successive drags 1/2 the length of the blade.

(d) Slip-Form Finishing. Construct the pavement with a preliminary float finish with devices incorporated in the slip-form paver. The Contractor may supplement these with suitable machine floats.

Correct the edge slump of pavement, exclusive of edge rounding, over 0.02 foot before concrete has hardened.

(6) Straightedge Testing and Surface Correction. After completing the floating and removing the excess water removed, but while the concrete is still plastic, test the surface of the concrete for trueness with a 10-foot straightedge. For this purpose, furnish and use an accurate 10-foot straightedge swung from a handle three feet longer than 1/2 the width of the slab. Hold the straightedge in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other as necessary. Advance along the road shall be in successive stages of not more than 1/2 the length of the straightedge. Immediately fill with freshly mixed concrete, strike off, consolidate, and refinish all depressions. Cut down and refinish high areas. Construct the surface across joints to meet the requirements for smoothness. Continue straightedge testing and surface corrections 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.

(7) Final Finish. After completing straight-edging and surface corrections and as soon as the water sheen has practically disappeared, texture the pavement surface uniformly. Apply the final finish or texture by the use of an artificial turf drag followed immediately by a metal comb transverse grooving device.

Use an artificial turf made of molded polyethylene with synthetic turn blades approximately 0.85 inches long and contain approximately 7,200 individual blades per square foot. Submit the artificial turf for acceptance by the Engineer.

Attach the artificial turf suitably to a device that will permit control of the time and rate of texturing. Do not attach this device to other pieces of equipment in the paving train. The device shall be a separate piece of equipment to be used exclusively for the texturing operation. The artificial turf shall be full pavement width and of sufficient size that during the finishing operation, approximately two feet of turf parallel to the pavement centerline is contacting the pavement surface so as to produce a uniform appearing surface according to the contract. When necessary for maintaining intimate contact with the pavement surface, the Contractor may down the turf.

The metal comb includes a single line of tempered spring steel spaced at 3/4 inch on centers. Mount the metal comb securely in a suitable head. The tines shall be of the size and stiffness sufficient to produce a groove of the specified dimension in the plastic concrete without slumping of the edge or severe tearing of the surface. Attach the metal comb to a mechanical device capable of transversing the entire pavement width in a single pass at a uniform speed. Operate the grooving device so as to produce a relatively uniform pattern of grooves perpendicular to the pavement centerline, spaced approximately 3/4 inch on centers, 1/8 inch to 3/16 inch deep, and 1/10 inch to 1/8 inch wide. Hand combs with steel tines shall be available for the purpose of providing a surface texture in event of breakdown of the mechanical comb. The Engineer may allow deviations from the stated dimensions providing a finish texture is produced according to the contract.

(8) Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, round the edges of the pavement along each side of each slab, on each side of the transverse expansion joints, and construction (contact) joints to a radius of 1/4 inch. Produce a well-defined and continuous radius and a smooth, dense mortar finish. Do not unduly disturb the surface of the slab by tilting the tool during use.

At joints, eliminate the tool marks appearing on the slab adjacent to the joints by brooming the surface. In doing this, do not disturb the rounding of the corner of the slab. Remove the concrete on top of the joint filler completely.

When one side of the joint is higher than the other or when the joint are higher or lower than the adjacent slabs, test the joints with a straightedge before the concrete has set and correction made.

(N) Surface Test. The finished pavement shall conform to the following requirements when tested by the Engineer not more than 14 days following the placement of concrete:

(1) Straightedge the pavement surface at locations determined by the Engineer with a straightedge 12 feet long. When laying the straightedge on a finished pavement in a direction parallel with centerline or normal to centerline, the surface shall not vary more than 0.25 inch from the lower edge.

(2) The Engineer will determine the profile of the pavement surface using a profilograph according to Hawaii Test Method HDOT TM 6 and these provisions. The Engineer will take the

profiles three feet from and parallel to each edge of pavement and at the approximate location of each longitudinal joint.

Make the request to the Engineer for profile testing at least 7 calendar days before testing the pavement surface. Clean and clear the area to be tested of obstructions. The Engineer will do the profilograph test up to two times per pavement surface test at no cost to the Contractor. Submit the total area to be tested at any time the request for testing is made for acceptance by the Engineer. The Engineer will do additional required profilograph testing at a cost to the Contractor at a rate of $750 per test per day.

During the initial paving operations, either startup or after a long shutdown, furnish, operate, and test the pavement surface using a California type profilograph when the concrete has cured sufficiently to allow testing.

Repair the membrane curing film damaged during the testing operations as specified by the Engineer. The Contractor and the Engineer will use the initial profile testing to aid and evaluate the paving methods and equipment. When an average profile index exceeds 15 inches per mile, suspend the paving operations. The Engineer will not allow the Contractor to resume until corrective action is taken. Test the subsequent paving operation according to the initial testing procedures.

Furnish paving equipment and employ methods that produce a riding surface having a profile index of 10 or less, except as provided herein. The Engineer may accept the initial profiles up to 15 with applicable price adjustments. The Engineer will not profile the pavements within 15 feet from each bridge approach slab or existing pavement that is joined by the new pavement. The Engineer will apply the surface requirement of Subsection 503.03(M)(3)(a) - Finishing Bridge Decks to these areas.

The Engineer will not require profile testing to the areas of pavement:

(1) on horizontal curves having a centerline radius of curve less than 1,000 feet and pavement within the superelevation transition of such curves.

(2) for exit ramp termini, ramps and connectors with steep grades and high rates of superelevation and short sections of roadway.

Reduce individual high points over 0.3 inch, as determined by measurements of the profilogram according to Hawaii Test Method 10, by grinding until such high points as shown by reruns of the profilograph do not exceed 0.3 inch.

After completing the grinding, do additional grinding as necessary to reduce the Profile Index to values specified in any 0.1 mile section along any line parallel with the pavement edge.

Do additional grinding as necessary to extend the area ground in each lateral direction so the lateral limits of grinding are at a constant offset from and parallel to, the nearest lane line or pavement edge. Also, do additional grinding as necessary to extend the area ground in each longitudinal direction so the grinding begins and ends at lines normal to the pavement centerline, within any one ground area. Ground areas shall be neat rectangular areas of uniform surface appearance.

When grinding pavement, do not finish the pavement to a smooth or polish texture. Grind the pavement to have a texture with uniformly spaced grooves, and in the direction specified by the Engineer.

The Engineer will not permit bush hammers or other impact devices.

Complete the corrective work before determining pavement thickness.

(O) Curing. When completing the finishing operations and when marring of the concrete does not occur, cover and cure the entire surface of the newly placed concrete according to one of the following methods shown below. When curing requires the use of water, the curing shall have priority to water supplies. Failure to provide sufficient cover material or lack of water to take care of both curing and other requirements shall be cause for immediate suspension of the concrete operations. Do not leave the concrete exposed for more than 1/2 hour between stages of curing or during the curing period. Maintain the covering in place for 72 hours after pouring the concrete.

(1) Cotton or Burlap Mats. Cover the entire surface of the pavement with mats. The mats used shall be of such length or width that as laid they extend at least twice the thickness of the pavement beyond the edges of the slab. Place the mats so that the entire surface and both edges of the slab are completely covered. Before placement, saturate the mats thoroughly with water. Place and weigh down the mats as to cause them to

remain in intimate contact with the surface covered. Maintain the covering fully wetted and in position for the required period.

(2) **Waterproof Paper.** Cover the entire top surface and sides of the pavement with waterproofed paper. Lap the units at least 18 inches. Place and weigh down the paper as to cause the paper to remain in intimate contact with the surface covered. The paper shall have such dimensions that each unit laid shall extend beyond the edges of the slab at least twice the thickness of the pavement or of pavement width and two foot strips of paper for the edges. When laid longitudinally, securely seal the paper not manufactured in sizes which shall provide this width so that they do not open up or separate during the curing period. Thoroughly wet the surface of the pavement before placing the paper.

(3) **Impervious Membrane Method.** Spray the entire surface of the pavement uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. When initially curing the pavement with jute or cotton mats, the white pigment curing compound may be applied upon removal of the mats. Do not apply the curing compound during rainfall.

Apply the curing compound under pressure at the rate of one gallon to not more than 150 square feet by mechanical sprayers. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, stir the compound continuously by effective mechanical means. The Engineer will permit hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms. Do not apply the curing compound to the inside faces of joints to be sealed.

When the curing film becomes damaged from causes within the required curing period, repair the damaged portions immediately with additional compound. Upon removal of side forms, protect the sides of the slabs exposed immediately to provide a curing treatment equal to that provided for the surface.

(4) **White Polyethylene Sheeting.** Cover the top surface and sides of the pavement entirely with polyethylene sheeting. Overlap the units at least 18 inches. Place and weigh down the sheeting as to cause the sheeting to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have a dimension that each unit as laid shall extend beyond the edges of the slab at least twice the thickness of the pavement.

(P) Removing Forms. Remove the forms from freshly placed concrete after the concrete has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. Remove the forms carefully so as to avoid damage to the pavement. After removing the forms, cure the sides of the slab as outlined in one of the methods indicated above. The Engineer will consider major honeycombed areas as defective work. Remove and replace the major honeycomb areas. Areas or sections removed shall not be less than 10 feet in length nor less than full width of the lane involved. When the removal and replacement of a section of pavement is necessary, also remove and replace remaining portion of the slab adjacent to the joints that is less than 10 feet in length.

(Q) Sealing Joints. When required by the contract, fill the joints with joint sealing material before the pavement is opened to traffic, and as soon after completion of the curing period is feasible. Clean each joint thoroughly of foreign matters including membrane curing compound and clean the joint faces and dry the surface before sealing. Stir the material during heating so that localized overheating does not occur.

Apply the sealer as required by the contract or as specified by the Engineer. Pour the sealer without spilling the material on the exposed surfaces of the concrete. Immediately remove and clean the material on the surface of the concrete pavement. The Engineer will not permit the use of sand or similar material as a cover for the seal.

(R) Protection of Pavement. Protect the pavement and its appurtenances against both public traffic and traffic caused by its own employees and agents. This shall include flaggers to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossover.

When by the Engineer, construct pavement crossings for the convenience of public traffic according to Subsection 104.04 - Maintenance of Traffic. The Engineer will not make additional compensation for the work involved.

Repair or replace damages to the pavement before final acceptance.

The Engineer will require the Contractor to have available materials for the protection of the edges and surface of the unhardened concrete. The protective materials include standard metal form or wood plank having a nominal thickness of not less than two inches and a nominal width of not less than the thickness of the pavement at its edges. The surface protective material includes burlap or cotton mats, curing paper, or plastic sheeting. When rain appears imminent, paving operations shall

stop. Place the forms against the sides of the pavement and cover the surface of the unhardened concrete with the protective covering.

(S) Opening to Traffic. Do not open the pavement to traffic until the specimen beams conforming to Subsection 411.03(J) - Test Specimens attain a flexural strength of 550 pounds per square inch when tested according to AASHTO T 97. Do not open the pavement to traffic before 7 days regardless of strength attainment.

Clean, sign, and mark the pavement properly and clear the pavement of obstructions before opening the roadway to public traffic.

The Engineer will not allow construction traffic, equipment, or materials on the pavement while the pavement is attaining the strength.

(T) Tolerance in Pavement Thickness. The Engineer will check the thickness of the pavement by cores taken by the Contractor according to AASHTO T 24. The Engineer will inform the Contractor to take core samples and observe the Contractor taking core samples. The Engineer will test the cores according to AASHTO T 148. Cores are to be taken to determine thickness acceptability after completion of corrective work.

When cores are taken to determine the thickness of PCC pavement, a layer of material may adhere to the bottom of the core. Before determining the thickness of the PCC pavement, the Engineer will remove non-PCC pavement materials from the bottom of the core.

The Engineer will evaluate the pavement on the basis of primary and secondary unit. The primary unit of pavement will be the area of mainline pavement placed during one day's paving operations. Additionally, the Engineer will consider each ramp including tapers, each intersection, each crossover as a separate primary unit.

A secondary unit of pavement includes 1,000 linear feet or fraction thereof, of each mainline traffic lane and each shoulder in each primary unit. Also, each 1,300 square yards of pavement in ramps, tapers, intersections, and crossroads will be a secondary unit regardless of when the concrete was placed.

Drill one core in each secondary unit. When the length of that core is not deficient by more than 0.2 inch from the planned thickness, the Engineer will pay for that secondary unit at 100% of the contract unit price.

When the length of that core is deficient by more than 0.2 inch but less than 0.6 inch, drill two additional cores within the secondary unit and the Engineer will average the length of the three cores.

When the core in a secondary unit is deficient by more than 0.6 inch, the Engineer will not use the core to determine the average thickness of the secondary unit.

Drill additional cores at intervals not exceeding 10 feet in each direction from the deficient core, measured parallel to the centerline, until one core is obtained in each direction which is not deficient by more than 0.6 inch.

The Engineer will evaluate the pavement between these two cores separately from the balance of the pavement in that secondary unit. The limits for the evaluation will be between the longitudinal weakened plane or construction joint on each side of the core and between the next transverse weakened plane, construction, or expansion joint beyond each of the last two cores. Unless the Engineer allows the pavement to remain, remove and replace the pavement with pavement of the specified thickness. The Engineer will not pay for the removal of the deficient pavement. When the deficient pavement is allowed to remain, the Engineer will not make payment for the deficient pavement. Drill one additional core in the remaining portion of the secondary unit. The Engineer will evaluate this portion separately for payment as hereinbefore specified.

When removing deficient pavement, remove and replace the deficient pavement within the evaluation limits. After replacing the deficient pavement, drill one core at random in the secondary unit outside of the limits of the replaced pavement and drill one core in the new pavement. The Engineer will evaluate the pavement represented by the drilled core taken outside of the limits of the replaced pavement for payment as hereinbefore specified. When the core drilled in the replaced pavement is less than the specified thickness, the Engineer will not make payment for the replaced pavement.

Fill the core holes completely with concrete of the same quality as used to construct the pavement.

411.04 Method of Measurement. The Engineer will measure the concrete pavement per cubic yard complete in place. The width for measurement will be the width of the pavement shown on the typical cross section of the plans, additional widening where called for, or as specified in writing by the Engineer. The Engineer will measure the length horizontally along the centerline of each roadway or ramp. The thickness for cubic yard measurement will be the

thickness of the pavement shown on the typical cross section of the plans or as specified in writing by the Engineer.

The Engineer will measure transverse contraction joints, other than transverse construction joint, per linear foot.

411.05 Basis of Payment. The Engineer will pay for the accepted PCC pavement at the contract unit price per cubic yard. The price includes full compensation for furnishing reinforcements, dowels, tie bars, other joint materials; furnishing, placing, and removing of forms, protection devices; furnishing and placing curing materials, furnishing and installing longitudinal joints, transverse expansion joints, and transverse construction joints; grinding and grooving; obtaining cores; backfilling holes with concrete; and furnishing labor, materials, tools, equipment, and incidentals necessary to complete the work.

When the average length of cores indicates pavement thickness is deficient by more than 0.2 inch but not more than 0.6 inch, only the reduced price stipulated below will be paid. The Engineer will not make additional payment over the unit contract bid price for pavements having an average thickness over that shown in the contract.

The Engineer will pay for the accepted transverse contraction joints, other than transverse construction joints, at the contract unit price per linear foot of joint. The price shall be full compensation for the furnishing and placing the joints; and furnishing materials, equipment, tools, labor, and incidentals necessary to complete the work.

The Engineer will make payment under:

Pay Item	**Pay Unit**
_____-inch, Concrete Pavement	Cubic Yard

(A) Price Adjustments. When the average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.6 inch, the Engineer will make payment at an adjusted price as specified in Table 411-I - Concrete Pavement Deficiency. Contract unit price in Table 411-I shall be the final adjusted unit price after adjustments for other deficiencies, if applicable

TABLE 411-I - CONCRETE PAVEMENT DEFICIENCY

Core Thickness, Less Than Specified Thickness, inch	Percent Of Contract Unit Price Allowed
0.00 to 0.20	100
0.21 to 0.40	75
0.41 to 0.60	40

When the thickness of pavement is deficient by more than one inch and the Engineer determines that the area of such deficiency should not be removed and replaced, the Engineer will not make payment for the area retained.

When the Engineer determines that the deficient areas warrant removal, remove and replace the deficient areas with concrete of the thickness shown in the contract. The Engineer will pay for the replacement according to the above.

When the profile index does not exceed ten, the Engineer will make payment at the contract unit price for the completed pavement. When the profile index exceeds ten, the Contractor may elect to accept a contract unit price adjustment in lieu of reducing the profile index. The Engineer will make the contract unit price adjustment according to the following schedule:

PROFILE INDEX	PRICE ADJUSTMENT (Percent of pavement unit bid price)
10 or less	100
Over 10 but less than 11	98
Over 11 but less than 12	96
Over 12 but less than 13	94
Over 13 but less than 14	92
Over 14 but less than 15	90
Over 15	Corrective work required

The Engineer will compute the unit bid adjusted price using the planned thickness of PCC pavement. This unit bid adjusted price will apply to the total area of the 0.1 mile section for the lane width represented by the profilogram."

END OF SECTION