

1 **SECTION 411 - PORTLAND CEMENT CONCRETE PAVEMENT**
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4 **411.01 Description.** This section describes constructing portland cement
 5 concrete (PCC) pavement, with or without reinforcement, on a prepared surface.
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7 **411.02 Materials.**

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9	Structural Concrete (minimum 14-day flexural strength, $f_r = 650$ psi)	601
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11	Joint Filler	705.01
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13	Joint Sealer	705.04
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15	Reinforcing Steel	709.01
16		
17	Curing Materials	711.01
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19 **411.03 Construction.**

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 21 **(A) Paving Plan.** Submit paving plan for review and acceptance by the
 22 Engineer. The Engineer will review the paving plan in accordance with
 23 Subsection 105.04 – Review and Acceptance Process. The plans include
 24 the following:
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- 26 (1) Mix design.
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- 28 (2) Construction method.
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- 30 (3) Description of mixing, placing, finishing, curing, and lighting
 31 equipment for night work.
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- 33 (4) Miscellaneous materials.
- 34
- 35 (5) If applicable, early usage of concrete pavement.
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- 37 (6) Location, sequence, and construction leave-outs indicated in
 38 the contract documents or required by the Contractor's operation.
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40 Submit revised paving plan prior to conducting work that deviates from
 41 plan accepted by the Engineer. Paving shall not start until the paving plan is
 42 acceptable to the Engineer.
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44 **(B) Equipment.**

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- 46 (1) **Batching Plant and Mixers.** Batching plant and mixers shall
 47 conform to Section 601 - Structural Concrete.
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(2) Hauling Equipment. Hauling equipment shall conform to Section 601 - Structural Concrete.

(3) Finishing Equipment.

(a) Finishing Machine. Finishing machine shall be self-propelled and equipped with at least two oscillating-type, transverse screeds that shall finish the surface to meet requirements specified in Subsection 411.03(N) - Surface Test and Subsection 411.03(T) - Pavement Thickness. Finishing equipment shall not displace reinforcement, side forms, or joints.

(b) Vibrators. Vibrators for full-width concrete consolidation may be either internal-type, with immersed tube or multiple spuds, or surface pan type. Vibrators shall be attached to spreader or finishing machine, or shall be mounted on separate carriage. Vibrators shall not come in contact with reinforcement, load transfer devices, subgrade, and side forms.

Furnish vibrators that operate at frequencies not less than the following: 3,500 impulses per minute for surface vibrators; and 5,000 impulses per minute for internal and hand vibrators. Furnish tachometer for measuring and indicating vibration frequencies.

(c) Mechanical Floats. Mechanical floats shall be self-propelled and designed to finish pavement surface uniformly smooth and true to grade. Run mechanical floats either on side forms or on adjacent lanes of concrete.

Floats shall be constructed of hardwood, steel, or steel-shod wood and shall be equipped with devices to permit adjusting underside to a true flat surface.

(d) Slip-Form Pavers. Slip-form pavers shall be self-propelled and equipped with traveling side forms of sufficient dimensions, shape, and strength to spread, consolidate, and screed freshly placed concrete in one complete pass, with minimum hand finishing. Pavers shall produce dense and homogeneous pavement, true to cross section and profile indicated in the contract documents.

Slip-form pavers shall be equipped with high-frequency internal vibrators that vibrate concrete for full paving width and depth.

97 Vibrators may be mounted with their axes either parallel
98 or normal to pavement alignment. Where vibrators are
99 mounted with their axes parallel to pavement alignment, space
100 vibrators at intervals not to exceed 2.5 feet, measured center
101 to center. Where vibrators are mounted with their axes normal
102 to pavement alignment, space vibrators such that lateral
103 clearance between individual vibrating units does not exceed
104 0.5 feet.

105
106 While pavement is being spread, compacted, and
107 shaped, operate vibrating units such that longitudinal axis, at
108 the center of each unit, is not more than 0.5 feet above existing
109 paving surface.

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111 Paving operations may be conducted using either one
112 machine or mechanical spreader followed by separate finishing
113 unit.

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115 **(4) Concrete Saw.** If sawed joints are specified or elected by the
116 Contractor, furnish power-driven concrete saws sufficient in number,
117 power, and type of blade to cut joints. Provide at least one back-up
118 saw and replacement blades during concrete sawing operations.
119 Equip saws with blade guards and guides or devices to control
120 alignment and depth. Remove all cuttings, slurry, and other by-
121 products of the sawing operations from the work site.

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123 **(5) Forms.** Use 10-foot-long straight side forms made of metal
124 having thickness not less than 7/32 inch, depth equal to prescribed
125 pavement edge thickness, and base width not less than 80 percent of
126 prescribed pavement thickness. Horizontal form joints will not be
127 allowed unless built-up forms, as specified in this subsection, are
128 accepted by the Engineer. Forms shall be sufficiently rigid to prevent
129 edge alignment distortion under subgrading and equipment loads or
130 concrete pressure, or combination thereof. Furnish form sections that
131 are straight, free from bends, warps, indentations, and other defects.
132 Sections that deviate from true plane along top of form more than 1/8
133 inch in 10 feet or along face of form more than 1/4 inch in 10 feet will
134 be rejected.

135
136 Join form lengths in a manner that ensures tight, neat joints at
137 form connections and prevents springing from occurring under
138 subgrading and paving equipment loads or concrete pressure, or
139 combination thereof. Built-up forms may be used by rigidly attaching
140 section of suitable width and thickness to either top or bottom of form.
141 If built-up is attached to top of form, use metal built-up.

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For curves of 100-foot radius or less, use flexible forms or curved forms having proper radius. Special forms of wood or metal may be used for curved form lines having radius of 200 feet or less. Five-foot-long, straight metal form sections may be used for curved form lines having radius greater than 100 feet. Straight metal forms in sections 10 feet or less in length may be used for form lines having radius greater than 200 feet.

Special forms of wood or metal may be used for curved form lines having radius of 200 feet or less. Where use of standard pavement forms is not feasible, submit working drawings at least 10 working days before production. Five-foot-long, straight metal form sections may be used for curved form lines having radius greater than 100 feet.

Use of wood forms as a track for operating paving and finishing equipment will not be allowed.

(C) Preparing the Proper Grade. Trim beyond edges of proposed concrete pavement to accommodate forms and slip-form paving equipment. Fill and compact areas that are below established grade with subgrade or base course material, in lifts up to 1/2 inch, for widths of 18 inches on both sides of form base. Tamp and trim areas above established grade, as necessary.

(D) Setting Forms. Before placing forms, compact foundation to ensure continuous contact with forms. Set forms and check for correct line and grade before placing concrete. Tamp inside and outside edges of form base. Use three pins for each 10-foot section to stake forms in place. Place pins on each side of every joint. Lock form sections to prevent play or movement in any direction. Forms shall withstand impact and vibration due to consolidation operations and shall remain true to within 1/4 inch. Before placing concrete, clean and coat forms with form release agent or oil, accepted by the Engineer. At least one working day prior to placing concrete, notify the Engineer that forms are ready for inspection.

(E) Conditioning of Subgrade or Base Course. Unless waterproof cover material is indicated in the contract documents, keep subgrade and base course uniformly moist before placing concrete.

(F) Handling, Measuring, and Batching Materials. Handle, measure, and batch materials in accordance with Section 601 - Structural Concrete.

(G) Mixing Concrete. Mix concrete in accordance with Section 601 - Structural Concrete.

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(H) Mixing Limitations and Water Supply. Provide for adequate natural or artificial lighting when mixing, placing, and finishing concrete.

Place mixed concrete only when concrete temperature is between 50 and 90 degrees F. Use Plastic Shrinkage Evaporation Chart ACI 305 as a guide to determine if additional precautions should be taken to prevent shrinkage cracks.

Before placing concrete pavement, provide adequate supply of water for entire work period. Inadequate water supply will be sufficient cause for delaying or stopping mixing operations. If there is a water supply deficiency, give first water-use priority to curing concrete already placed before using water for mixing concrete.

(I) Placing, Consolidating, and Shaping Concrete.

(1) General. Make advance arrangements for preventing delay in concrete delivery and placement. An interval of more than 45 minutes between placement of two consecutive batches or loads shall constitute cause for stopping paving operations and requiring construction joint to be placed, at no increase in contract price or contract time, at location and of the type ordered by the Engineer.

Prior to placing concrete, demonstrate proper adjustment of screeds and floats on slip-form pavers by measurements from grade stakes driven to known elevations. Placement of concrete shall not start until this is done. Demonstrate satisfactory operation and adjustments of propulsion and control equipment, including pre-erected grade and alignment lines, by running slip-form pavers and finishing machines over 500-foot length of prepared subgrade or base course with propulsion and control equipment fully operational.

Unless otherwise indicated in the contract documents, construct pavement in full-lane widths separated by longitudinal weakened plane joints, or monolithically in multiples of full-lane widths, with longitudinal weakened plane joints at each traffic lane line.

Deposit concrete with minimum of handling. Spread concrete uniformly over entire area between forms, without segregation, using mechanical spreader. Where hand methods are necessary due to pavement design, equipment breakdown, or other factors, use shovels, not rakes, for hand spreading. Place concrete continuously between transverse joints without using intermediate bulkheads. Prohibit workers from walking in concrete with boots or shoes coated with earth or foreign substances.

411.03

236 Improperly proportioned concrete will be rejected. Remove
237 and dispose of concrete rejected by the Engineer in accordance with
238 Subsection 201.03(E) - Removal and Disposal of Material, at no
239 increase in contract price or contract time.

240
241 Spread, consolidate, and shape concrete so that completed
242 pavement will conform to thickness and cross-sectional requirements
243 indicated in the contract documents. Sides of pavement may be
244 constructed with batter not exceeding one horizontal to six vertical,
245 provided that pavement top width is maintained as indicated in the
246 contract documents.

247
248 Where widening PCC pavement contiguous with existing
249 parallel concrete pavement not constructed as part of the contract,
250 spread, consolidate, and shape concrete so that completed pavement
251 will conform to thickness and cross-sectional requirements indicated
252 in the contract documents and to the following:

253
254 **(a)** Elevation of completed pavement surface shall be such
255 that water will not pond on either sides of longitudinal joint with
256 existing pavement.

257
258 **(b)** New pavement surface at longitudinal joint shall
259 conform to elevation of existing concrete pavement. If
260 necessary, provide smooth transition between new and
261 existing pavement by hand finishing new pavement within one
262 foot of existing pavement, adding or removing concrete, as
263 necessary.

264
265 **(c)** Transverse straightedge, longitudinal straightedge, and
266 Profile Index requirements specified in Subsection 411.03(M) -
267 Final Strike-Off, Consolidation, and Finishing and Subsection
268 411.03(N) - Surface Test will not apply to pavement surface
269 within 1-foot of existing concrete pavement unless in the
270 opinion of the Engineer the surface finish of the installed
271 concrete pavement exhibits poor workmanship, e.g., finished
272 surface is rougher than existing surface, roughness of surface
273 cannot be attributed to the existing concrete pavement.

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275 **(d)** Profiles of completed pavement surface specified in
276 Subsection 411.03(N) - Surface Test will not be required within
277 four feet of longitudinal contact joint with existing concrete
278 pavement unless in the opinion of the Engineer the surface
279 finish of the installed concrete pavement exhibits poor
280 workmanship, e.g., finished surface is rougher than existing
281 surface, roughness of surface cannot be attributed to the
282 existing concrete pavement.

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284 (e) Thickness measurements specified in Subsection
285 411.03(T) - Pavement Thickness will not be made in pavement
286 within one foot of existing concrete pavement.

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288 (f) Transverse weakened plane joints shall be constructed
289 in pavement widening to match spacing and skew of weakened
290 plane joints in existing pavement.

291
292 Where concrete is to be placed adjacent to previously
293 constructed pavement, keep mechanical equipment off previously
294 constructed pavement until that concrete pavement has attained
295 flexural strength of not less than 550 pounds per square inch when
296 tested in accordance with AASHTO T 97.

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298 Where concrete is being placed adjacent to existing pavement,
299 provide that part of equipment supported on existing pavement, with
300 protective pads on crawler tracks or rubber tired wheels; and offset
301 bearing surface to run a sufficient distance from pavement edge to
302 avoid breaking or cracking that edge.

303
304 **(2) Stationary Side Form Construction.** Provide sufficient
305 quantity of forms so that there shall be no delay due to lack of forms.
306 Spread, consolidate, and shape concrete by one or more machines.
307 Use machines that uniformly distribute and consolidate concrete
308 without segregation, so that completed pavement conforms to cross
309 section indicated in the contract document, with minimum handwork.

310
311 Furnish paving machines in sufficient number and capacity to
312 finish work at rate equal to that of concrete delivery.

313
314 Consolidate concrete for full paving width using surface or
315 internal vibrators, or by other method of consolidation that produces
316 equivalent results without segregation.

317
318 Operate vibrators at manufacturer's recommended frequencies
319 based on compatibility with pertinent factors, including the following:
320 mix design, concrete slump, paver speed, and vibrator spacing.
321 Vibration amplitude shall be sufficient to be perceptible on concrete
322 surface more than one foot from vibrating element.

323
324 Do not rest vibrators on new pavement or side forms. Connect
325 power to vibrators so that vibration ceases when forward or backward
326 motion of machine is stopped.

327
328 **(3) Slip Form Construction.** Slip form paving equipment shall
329 spread, consolidate, and screed freshly placed concrete to produce
330 dense, homogeneous pavement, true to cross section and profile,
331 with minimum handwork.

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333 Use reference lines outside the finished concrete limits to
334 regulate paver alignment and elevation during concrete placing and
335 finishing operations. Abrupt changes in longitudinal alignment will not
336 be allowed. Limit horizontal deviation to no more than 0.1 foot from
337 alignment established by the contract documents.

338
339 Coordinate operations of mixing, delivering, and spreading
340 concrete to allow slip form paving equipment to operate in continuous
341 forward movement, with minimal stopping and starting. When paver
342 forward movement is stopped, immediately cease vibrating and
343 tamping operations. Do not apply tractive force to paving machine
344 except that which is controlled from the machine.

345
346 Consolidate concrete for full paving width using high-frequency
347 vibrators. Operate vibrators at manufacturer's recommended
348 frequencies based on compatibility with pertinent factors, including the
349 following: mix design, concrete slump, paver speed, and vibrator
350 spacing. Vibration amplitude shall be sufficient to be perceptible on
351 concrete surface along entire length of vibrating units and for a
352 distance of at least one foot therefrom.

353
354 **(J) Test Specimens.** Furnish concrete necessary for casting test beams
355 and cylinders and for testing air and slump. Unless otherwise indicated in
356 the contract documents, furnish, maintain, and clean beams or cylinder
357 molds, or both. Beams or cylinder molds, or both shall conform to AASHTO
358 T 23. Cure beams, as specified for pavement, in accordance with AASHTO
359 T 23. For early opening to traffic, cure flexural test specimens at same time
360 and in same manner as pavement.

361
362 Additional flexural strength test specimens will be required due to
363 concrete placement conditions or to determine concrete strength where early
364 opening of pavement to traffic is dependent on concrete strength test results.

365
366 **(K) Striking-Off Concrete and Placing Reinforcing Steel.** After
367 placement, strike off concrete to cross section indicated in the contract
368 documents.

369
370 Where pavement is placed in two layers, strike off and consolidate
371 bottom layer to depth necessary to place fabric or reinforcing steel mat
372 directly on concrete. Support reinforcing steel as needed to maintain its
373 correct position.

374
375 Place top layer within 30 minutes of first layer, or remove and replace
376 lower layer with freshly mixed concrete.

377
378 Where pavement is placed in one layer, position reinforcing steel
379 before placing concrete.

380
381 For reinforcing steel, Subsection 602.03(B) - Storage, Surface
382 Condition, and Protection of Reinforcement shall apply.
383

384 **(L) Joints.** Construct joint faces normal to pavement surface, as
385 indicated in the contract documents. Use chalk line, string line, sawing
386 template, or other methods to provide true joint alignment. Prior to contract
387 acceptance, maintain joints free of soil, gravel, concrete or asphalt mix, and
388 other foreign material except filler material.
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390 Where sawing method is used to cut pavement grooves, use saw
391 conforming to Subsection 411.03(B)(4) - Concrete Saw. Saw joints before
392 uncontrolled shrinkage cracking occurs, but only after concrete has hardened
393 sufficiently to prevent excessive tearing or raveling, or both during sawing
394 operations. Determining concrete readiness for sawing transverse
395 contraction and longitudinal joints in accordance with requirements specified
396 herein shall be the Contractor's responsibility. Cut grooves to minimum width
397 possible for type of saw used, but limit groove width to 0.02 foot.
398

399 Once sawing has commenced for any day's concrete placement,
400 continue sawing for 12 hours after placement. Should sawing fail to be
401 completed within 12 hours of concrete placement, limit subsequent concrete
402 placements to quantities that can be sawed in 12 hours. Restore curing
403 membrane disturbed during sawing operations by spraying disturbed areas
404 with additional curing compound.
405

406 **(1) Longitudinal Joints.** Place deformed tie bars, two-piece
407 connectors accepted by the Engineer, and smooth dowels, as
408 indicated in the contract documents, perpendicular to longitudinal
409 joint. Deformed tie bars and two-piece connectors shall be 30 inches
410 long, Grade 60 No. 5 bars, placed 30 inches apart at mid-depth of
411 slab. Where deformed tie bars are to be bent and later straightened,
412 use Grade 40 bars. Place bars using mechanical equipment, or
413 secure bars with chairs or other supports in accordance with Section
414 602 - Reinforcing Steel. Use other required sizes, grades, lengths,
415 and spacings, based on slab width, thickness, and type of underlying
416 base.
417

418 Unless otherwise indicated in the contract documents, tie bars
419 may be inserted into plastic concrete. If this method results in tie bar
420 misalignment, poor consolidation around tie bars, or concrete surface
421 or edge slumping, or combination thereof, discontinue using this
422 method and complete work using other methods accepted by the
423 Engineer.
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425 Construct longitudinal joints by sawing method at traffic lane
426 lines in multilane, monolithic concrete pavement. Cut longitudinal
427 joint to minimum depth $d = t/3$, where:

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d = minimum depth of cut, rounded up to nearest 0.01 foot;
t = greatest pavement thickness (feet) in each lane.

Where adjacent lanes are constructed separately, use deformed tie bars or smooth dowels, as indicated in the contract documents. Two-piece connectors accepted by the Engineer may be used.

Clean all joint faces of any curing compound, primer or any material that may be deleterious to the bonding of the new concrete to the existing or previously poured concrete.

(2) Transverse Expansion Joints. Extend transverse expansion joint to full cross section of PCC pavement and install continuous piece of preformed joint material. Where installing joint filler, depress filler 1/2 inch below pavement surface.

Hold expansion joint filler in vertical position and limit deviation to not more than 1/4 inch from straight line along centerline of joint. Hold filler on line with metal channel. Remove channel after initial concrete set.

(3) Transverse Contraction Joints. Construct transverse contraction joints by forming or sawing grooves in pavement surface. Where indicated in the contract documents, include dowel bars and assemblies.

Transverse contraction joints may be formed by depressing tool or device into plastic concrete before initial concrete set.

If uncontrolled shrinkage cracking occurs during or before joint sawing, modify sawing sequence accordingly or use other methods accepted by the Engineer. If necessary to eliminate uncontrolled shrinkage cracking, add more sawing units or use early entry concrete cutting machines with special blades that cut through relatively fresh concrete without needing water. Where transverse crack occurs prior to sawing and any point on crack is within 5 feet of planned transverse contraction joint, omit sawing planned joint.

Unless otherwise indicated in the contract documents, construct groove between depths of 1/3 to 1/4 of pavement thickness.

(4) Construction Joints. When concrete placement is interrupted for more than 30 minutes, construct longitudinal and transverse construction joints in accordance with the contract documents. Placement of construction joint within 10 feet of another transverse joint will not be allowed. At time of interruption, if sufficient concrete

476 has not been mixed to form slab greater than 10 feet long, remove
 477 and dispose of concrete back to preceding joint, at no increase in
 478 contract price or contract time. When concrete placement is stopped,
 479 provide bulkhead having sufficient cross-sectional area to prevent
 480 deflection, notched to receive dowels, and shaped to pavement cross
 481 section. Bulkhead shall be placed perpendicular to the baseline and
 482 shall also be one straight across the entire width of the pavement.
 483

484 **(5) Dowels for Longitudinal, Transverse, Expansion, and**
 485 **Contraction Joints.** As indicated in the contract documents, provide
 486 smooth, straight dowels, conforming to Subsection 709.01(E) -
 487 Dowels; and deformed dowels conforming to Subsection 709.01(F) -
 488 Tie Bars.

489
 490 At transverse joints, space dowels in pavement at one-foot
 491 centers, parallel to pavement surface and traffic direction.
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493 Use joint assemblies or wire baskets that remain in pavement
 494 to hold dowels in place during concrete placement and finishing. For
 495 referencing, properly mark center of dowel assembly on both sides of
 496 pavement slab.
 497

498 For expansion joints, unless otherwise indicated in the contract
 499 documents, use dowels with one end of each coated dowel encased
 500 in cap conforming to Subsection 709.01(E)(2) - Joint Dowels.
 501

502 Place dowels in pavement with alignment tolerance of $\pm 1/4$
 503 inch per dowel and depth $d = t/2$, where:

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 505 d = minimum depth, rounded up to nearest 0.01 foot;
 506 t = pavement thickness (feet) in each lane.
 507

508 Maintain dowel position and arrangement when placing and
 509 consolidating concrete around dowels.
 510

511 Unless otherwise indicated in the contract documents, coat
 512 entire length of each dowel with de-bonding material accepted by the
 513 Engineer. At the Contractor's option, dowels may be lightly coated
 514 with grease accepted by the Engineer. Use of cutback asphalts,
 515 emulsions, or oils will not be allowed for coatings.
 516

517 **(M) Final Strike-Off, Consolidation, and Finishing.**
 518

519 **(1) Sequence.** Sequence operations as follows: strike-off,
 520 consolidate, float, remove laitance, straightedge, and perform final
 521 surface finish. Provide work bridges and other equipment necessary
 522 to reach pavement surface to inspect, straightedge, finish, and
 523 perform corrective work as necessary.

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Finish concrete surface without adding water to surface.

(2) Finishing at Joints. Strike-off, consolidate, and finish, in a manner that does not damage or misalign, or both, joint assemblies, load transfer devices, and other embedded items. Vibrate concrete mechanically next to joints without creating voids or segregation, or both.

If finishing operation causes segregation, damage, or joint misalignment, or combination thereof, stop finishing equipment when screed is approximately 8 inches from joint. Remove segregated concrete surrounding joint. Lift front screed and set it directly over joint before continuing forward motion. Lift and carry second screed over joint when it is close enough to force excess mortar over joint. If segregation is prevented, subsequent finishing over joint without lifting screeds will be allowed.

(3) Machine Finishing.

(a) Nonvibratory Method. Use finishing equipment to strike off, screed, and texture concrete immediately after it is distributed or spread. Avoid excessive finishing. Keep top of forms free of concrete and debris.

Maintain uniform ridge of concrete along entire paving width and ahead of screed during first pass of finishing machine.

(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 concrete density is not obtained by vibratory method, furnish other equipment and methods that produce pavement conforming to the contract. Where not in conflict with provisions in Subsection 411.03(M)(3)(a) – Nonvibratory Method, provisions for vibratory method, shall govern.

(4) Hand Finishing. Use hand-finishing methods only under the following conditions and locations:

(a) When mechanical equipment breaks down, stop concrete placement and hand-finish concrete already in place.

(b) In areas of narrow widths or irregular shapes, hand-finish those areas that cannot be finished by mechanical equipment.

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(c) Hand floating in other portions of the contract documents shall be performed.

Use portable screed to strike-off and screed concrete. Provide second portable screed to strike-off bottom concrete layer when placing reinforcing steel during two-layer concrete placement.

Use metal screed or metal-reinforced screed, that is at least 2 feet longer than widest part of slab to be placed.

Consolidate concrete with hand-operated vibrator.

Move screed along forms in forward motion that combines longitudinal and transverse shearing motion without raising either end from side forms. Repeat this strike-off process until pavement is true to grade and cross section, and surface texture is uniform and free of porous areas.

(5) **Floating.** After striking off and consolidating concrete, use float to finish surface to specified grade and smoothness. Use one of the following methods:

(a) **Hand Method.** Use hand-operated, longitudinal float at least 12 feet long and 6 inches wide and sufficiently rigid to retain its shape. Operate longitudinal float from footbridges. Work float in sawing motion while holding it in position parallel to road centerline and passing it gradually from one side of pavement to the other.

Move ahead along pavement centerline, advancing not more than one-half of float length. Waste excess water and laitance over side forms on each pass.

(b) **Mechanical Method.** Adjust tracks and float to required crown. Coordinate float with adjustments of transverse finishing machine so that small quantity of mortar is maintained ahead of float. Operate float over pavement as few times and at such intervals as is necessary to produce surface of uniform texture. Excessive operation over a given area will not be allowed. Waste excess water and laitance over side forms on each pass.

(c) **Alternate Mechanical Method.** Use equipment with cutting and smoothing float or floats, suspended from and guided by rigid frame mounted on four or more visible wheels. Maintain constant contact of all four wheels with forms.

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After mechanical floating, use hand method to fill open-textured areas in pavement or if the method does not provide an acceptable finish. .

(d) Slip-Form Finishing. Construct pavement with preliminary float finish using devices incorporated in slip-form paver. Suitable machine floats may be used to supplement finish achieved by slip-form paver.

Before concrete has hardened, correct pavement edge slump, exclusive of edge rounding, in excess of 0.02 foot.

(6) Straightedge Testing and Surface Correction. After completing floating and removing excess water and laitance, correct surface irregularities while concrete is plastic. Fill, strike-off, consolidate, and refinish depressions. Cut down and refinish high areas. Smooth surface across joints to tolerances indicated in the contract documents.

Test concrete surface for trueness using 10-foot straightedge swung from handle that is 3 feet longer than one-half of slab width. Hold straightedge in contact with surface in successive positions parallel to road centerline. Test entire pavement width, moving from one side of slab to the other, as necessary. Advance testing operation along road, in successive stages of not more than one-half straightedge length.

(7) Final Finish. After surface sheen has disappeared, texture pavement surface without tearing it. Texture final surface using artificial turf drag followed immediately by metal comb transverse grooving device.

Use artificial turf made of molded polyethylene with synthetic turn blades measuring approximately 0.85 inches long and containing approximately 7,200 individual blades per square foot. Submit sample of artificial turf at least five working days before production.

Attach artificial turf to self-propelled equipment having external alignment control. Device shall be separate piece of equipment to be used exclusively for texturing operation and shall not be attached to other paving-train equipment. Artificial turf shall be full pavement width and of sufficient size that during finishing operation, approximately 2 feet of turf, parallel to pavement centerline, is in contact with pavement surface. Maintain downward pressure on pavement surface with turf, so as to achieve uniform texturing without measurable variations in pavement profile.

666 Metal comb shall include single line of randomly spaced,
 667 tempered spring steel tines of size and stiffness sufficient to produce
 668 grooves of specified dimensions in plastic concrete without edge
 669 slumping and severe surface tearing. Attach metal comb to
 670 mechanical device capable of traversing entire pavement width in
 671 single pass at uniform speed. Operate grooving device to produce
 672 random pattern of grooves perpendicular to pavement centerline.
 673 Randomly spaced grooves shall have in the harden pavement surface
 674 a minimum spacing of 0.4 inch and maximum spacing of 1.5 inches
 675 between centers, with no more than 50 percent of spaces exceeding
 676 1 inch, 1/8 inch to 3/16 inch deep, and 1/10 inch to 1/8 inch wide.
 677 Provide hand combs with steel tines to use in event of mechanical
 678 comb breakdown.

679
 680 Ramps, tapers, and miscellaneous areas may be textured
 681 manually.

682
 683 **(8) Edging at Forms and Joints.** After final finish, tool pavement
 684 edges to radius of 1/4 inch, along both sides of each slab; and on
 685 both sides of transverse expansion joints, formed joints, and
 686 construction joints. Produce smooth, dense mortar finish.

687
 688 Eliminate tool marks on slab, next to joints. Avoid disturbing
 689 rounding of slab corners. Remove concrete from joint filler top.

690
 691 Before concrete sets, test joints with straightedge and correct
 692 unevenness between joints and adjacent slabs.

693
 694 **(N) Surface Test.** Request testing to take place not more than 14 days
 695 following concrete placement. If the Engineer does not test the surface until
 696 after the 14-day period, the results shall be accepted as if it took place within
 697 the 14-day time period. Finished pavement shall conform to the following
 698 requirements when tested by the Engineer:

699
 700 **(1)** Conduct surface test using 12-foot straightedge at locations
 701 determined by the Engineer. When straightedge is laid on finished
 702 pavement in direction parallel or normal to centerline, surface shall
 703 not vary more than 1/4 inch from lower edge.

704
 705 **(2)** The Engineer will determine profile of pavement surface using
 706 profilograph in accordance with HDOT TM 6 and these specifications.
 707 The Engineer will take profiles 3 feet from and parallel to each
 708 pavement edge and at approximate location of each longitudinal joint.

709
 710 Make profile test request to the Engineer at least seven
 711 calendar days before desired testing date. When request for testing
 712 is made, submit total area to be tested. Clean and clear obstructions
 713 from area to be tested. The Contractor shall provide traffic control for

714 profilograph testing. The Engineer will perform initial and one follow-
715 up profilograph test, at no cost to the Contractor. Based on initial
716 profilogram, the Contractor shall perform remedial work before
717 requesting follow-up profilograph testing. The Contractor shall
718 perform additional remedial work and the Engineer will perform follow-
719 up testing until acceptable surface is obtained. Additional testing,
720 beyond initial test and one follow-up, will be performed at cost to the
721 Contractor of \$1,000 per test per day.

722
723 During initial paving operations or after a long shutdown, when
724 concrete has cured sufficiently to allow testing, furnish, operate, and
725 test pavement surface using California-type profilograph, to calculate
726 profile index.

727
728 Repair curing membrane damaged during surface remediation
729 and testing operations.

730
731 The Contractor and the Engineer will use initial profile testing
732 results to aid in evaluating paving methods and equipment. When
733 average profile index exceeds 15 inches per mile, suspend paving
734 operations. Resumption of paving operations will not be allowed until
735 corrective action is taken and accepted by the Engineer. Subsequent
736 paving operations will be tested in accordance with initial testing
737 procedures.

738
739 Use paving equipment and methods that produce riding
740 surface having profile index of 10 or less, except as provided herein.

741
742 Profile testing will not be required for the following pavement
743 areas:

744
745 **(a)** Within superelevation transition on horizontal curves
746 having centerline curve radius less than 1,000 feet.

747
748 **(b)** Within 15 feet of transverse joint that separates
749 pavement from existing pavement not constructed under the
750 contract or from structural deck or approach slab.

751
752 Reduce individual high points over 0.3 inch, as determined by
753 profilogram measurements in accordance with HDOT TM 6, by
754 grinding until such high points shown by profilograph reruns do not
755 exceed 0.3 inch.

756
757 After completing grinding of high points, perform additional
758 grinding as necessary to reduce Profile Index in accordance with
759 requirements specified in Subsection 411.05 – Payment.

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

Do not grind pavement to smooth or polished finish. Unless otherwise indicated in the contract documents, grinding shall provide a line-type texture that contains parallel, longitudinal corrugations with ridge peaks approximately 1/16 inch higher than groove bottoms; and with 55 to 60 evenly spaced grooves per foot. Pick up grinding-operation residue using vacuum attached to grinding machine. Prevent residue from flowing across pavement and from being left on pavement surface. Dispose of grinding residue.

Use of bush hammers and other impact devices will not be allowed for pavement surface remediation.

Complete corrective work before determining pavement thickness in accordance with Subsection 411.03(T) - Pavement Thickness.

(O) Curing. After finishing operations have been completed and as soon as marring of concrete will not occur, cure entire newly placed concrete surface and edges in accordance with one of the methods described in this subsection. When curing requires use of water, assign highest priority for project water supply allocation to curing operations. Suspend concrete operations if there is insufficient cover material or water supply for curing and other project requirements. Do not leave concrete exposed for more than 30 minutes between stages of curing or during curing period. Use atomized fog spray to place water into the air to increase the humidity as an interim cure or other methods accepted by the Engineer until final curing medium is in place. Cure concrete for at least 72 hours immediately after finishing operation.

(1) Cotton or Burlap Mats. Cover surfaces to be cured with cotton or burlap mats having dimensions that when placed, extend at least 2 feet beyond edges of concrete strip placed. Overlap mats at least 6 inches. Place and maintain mats in complete contact with surface being cured, throughout curing period. Keep mats fully moist and in position for entire portion of required cotton or burlap curing period.

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(2) Waterproof Paper. Thoroughly wet pavement surface and edges before placing paper. Cover surfaces to be cured with waterproof paper, sized to extend when sheets are placed, at least 2 feet beyond edges of concrete strip; or sized to match pavement width and supplemented with 2-foot paper edge strips. Overlap sheets at least 18 inches. Place and maintain paper in complete contact with surface being cured, throughout curing period. When sheets are laid longitudinally, seal paper so that it does not open up or separate during curing period.

(3) White-Pigmented Curing Compound. Immediately after finishing surface and before concrete set has taken place, spray uniformly surfaces to be cured with white-pigmented curing compound. When cotton or burlap mats are used to initially cure pavement, apply white-pigmented curing compound upon removal of mats. Do not apply curing compound during and immediately after rainfall.

Use fully atomized mechanical sprayer equipped with tank agitator and wind guard to apply curing compound, under pressure, at rate of at least one gallon per 100 square feet. Before spraying, compound shall be in thoroughly mixed condition with pigment uniformly dispersed throughout vehicle. Mechanically agitate compound continuously during application. Hand-pump sprayers will be allowed only for spraying irregular widths and shapes and concrete surfaces exposed by form removal. Do not apply curing compound to inside faces of joints to be sealed. Provide means to verify application rate.

If curing film is damaged during required curing period, immediately repair damaged portions with additional curing compound. Upon removal of side forms, immediately protect exposed slab edges with curing treatment equivalent to that provided for pavement surface.

(4) White Polyethylene Sheeting. Cover surfaces to be cured with polyethylene sheeting, sized to extend when sheets are placed, at least 2 feet beyond edges of concrete strip. Overlap sheets at least 18 inches. Place and maintain sheeting in complete contact with surface covered, throughout curing period.

(P) Removing Forms. Keep forms in place for at least 12 hours. Protect pavement from damage during form removal. After removing forms, immediately cure exposed surfaces in accordance with Subsection 411.03(O) - Curing. Pavement areas containing major honeycombed areas will be rejected. Remove and replace rejected pavement areas that are full-lane-wide sections and at least 10 feet long; and in those areas where

853 removal and replacement are necessary, remove remaining portions of slab
854 that are less than 10 feet long and adjacent to joints.

855

856 **(Q) Sealing Joints.** Clean and seal joints after completion of curing
857 period and before pavement is opened to traffic. Clean each joint thoroughly
858 of foreign matter, including debris, dirt, dust, concrete, saw cuttings, and
859 curing material. Collect and dispose of all removed material.

860

861 Dry joint surfaces before sealing joint. Apply sealing material as
862 indicated in the contract documents. If hot sealer is used, stir material during
863 heating to prevent localized overheating. Pour sealing material without
864 spilling on exposed concrete pavement surfaces. Immediately remove and
865 clean excess material from pavement surface. Use of sand or similar
866 material as a cover for sealing material will not be allowed.

867

868 **(R) Protection of Pavement.** Protect pavement and its appurtenances
869 from public and construction traffic. Protection shall include using flaggers to
870 direct traffic; and erecting and maintaining warning signs, lights, pavement
871 bridges, and crossovers.

872

873 Where indicated in the contract documents, construct pavement
874 crossings for convenience of public traffic in accordance with Subsection
875 104.09 - Maintenance of Traffic.

876

877 Furnish and install materials for edge and surface protection of
878 unhardened concrete. Edge protection materials include standard metal
879 forms and wood planks having nominal thickness of not less than 2 inches
880 and nominal width of not less than pavement-edge thickness. Surface
881 protection materials include burlap or cotton mats, curing paper, and plastic
882 sheeting. Stop paving operations when rain appears imminent.

883

884 Repair or replace damaged pavement before final acceptance.

885

886 **(S) Opening to Traffic.** Allow traffic on pavement when test specimens
887 conforming to Subsection 411.03(J) - Test Specimens have attained flexural
888 strength of 550 pounds per square inch when tested in accordance with
889 AASHTO T 97. Traffic will not be allowed on pavement sooner than seven
890 days after concrete placement, regardless of strength attainment.

891

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

894

895 Construction traffic, equipment, and materials will not be allowed on
896 pavement during curing period.

897

898 **(T) Pavement Thickness.** The Engineer will determine coring locations
899 and observe coring operation. The Engineer will check thickness of
900 pavement by cores obtained by the Contractor in accordance with

411.03

901 AASHTO T 24. The Engineer will measure cores in accordance with
902 AASHTO T 148, except that measurement will be taken to nearest one
903 thousandth of an inch; and average of such measurements will be taken to
904 nearest one hundredth of an inch. Take thickness core samples after
905 completion of corrective work.

906
907 The Engineer will remove non-PCC pavement materials from bottom
908 of core before determining pavement thickness.

909
910 Thickness core samples will be evaluated on basis of primary and
911 secondary units. Primary pavement unit is defined as that area of mainline
912 pavement placed in each day's paving operations, but not to exceed 1,300
913 square yards. Each ramp, including tapers, each intersection, and each
914 crossover will be considered separate primary units. Drill one core for each
915 primary unit.

916
917 Secondary pavement unit is defined as 1,000 linear feet, or fraction
918 thereof, of each mainline traffic lane and each shoulder in each primary unit.
919 Additionally, each 1,300 square yards of pavement in ramps, tapers,
920 intersections, and crossroads will be considered secondary units, regardless
921 of when concrete was placed. Drill one core for each secondary unit.

922
923 When the primary or secondary unit core is deficient by more than 0.2
924 inch but less than 0.6 inch, drill two additional cores within same secondary
925 unit. Length of initial and two additional cores will be averaged.

926
927 When the primary or secondary unit core is deficient by more than 0.6
928 inch, that core will not be used to determine average thickness of the primary
929 or secondary unit. Drill additional cores at intervals not exceeding 10 feet in
930 each direction from deficient core, measured parallel to centerline, until one
931 core is obtained in each direction, which is not deficient by more than 0.6
932 inch. Pavement thickness between these two additional cores will be
933 evaluated separately from balance of pavement in that lot.

934
935 Pavement limits for separate evaluation will be longitudinal weakened
936 plane or construction joint on each side of core and next transverse
937 weakened plane, construction, or expansion joint, beyond each of last two
938 cores. Unless the Engineer allows pavement within evaluation limits to
939 remain, remove and replace with pavement of specified thickness, at no
940 increase in contract price or contract time. Drill one additional core in
941 remaining portion of the primary or secondary unit. That portion will be
942 evaluated separately for payment in accordance with provisions specified in
943 Subsection 411.05 - Payment.

944
945 After replacing deficient pavement, drill one core at random in the
946 primary or secondary unit beyond limits of replaced pavement and drill one
947 core in replaced pavement. The Engineer will evaluate for payment,
948 pavement represented by core taken beyond limits of replaced pavement in

949 accordance with provisions specified in Subsection 411.05 - Payment.

950

951 Before filling, apply epoxy grout conforming to Subsection 712.04(B) -
952 Epoxy Grout to core holes. Fill core holes completely with concrete accepted
953 by the Engineer.

954

955 **411.04 Measurement.**

956

957 **(A)** Concrete pavement will be paid on a lump sum basis. Measurement
958 for payment will not apply.

959

960 **(B)** The Engineer will measure transverse contraction joints per linear foot
961 in accordance with the contract documents.

962

963 **411.05 Payment.** The Engineer will pay for the accepted pay items listed below
964 at the contract price per pay unit, as shown in the proposal schedule. Payment will
965 be full compensation for the work prescribed in this section and the contract
966 documents.

967

968 The Engineer will pay for each of the following pay items when included in
969 the proposal schedule:

970

971 Pay Item	972 Pay Unit
973 Concrete Pavement	974 Lump Sum
975 Transverse Contraction Joint	976 Linear Foot

976

977 The Engineer will pay for:

978

979 **(A)** 80 percent of the contract bid price upon completion of furnishing and
980 placing formed joints or cutting grooves in pavement.

981

982 **(B)** 20 percent of the contract bid price upon completion of cleaning up,
983 including removal of saw-cutting residue.

984

985 When the primary or secondary unit core thickness is deficient by not more
986 than 0.2 inch from planned thickness, the Engineer will pay for that primary or
987 secondary unit at 100 percent.

988

989 When the primary or average secondary unit core thickness indicates
990 pavement thickness is deficient by more than 0.2 inch but not more than 0.6 inch,
991 the Engineer will determine pay for that the primary or secondary unit an adjusted
992 price that will be the final adjusted price after adjustments have been made for other
993 deficiencies, if any are applicable.

994

995 The Engineer will not pay for pavement allowed to remain with thickness
996 deficiency greater than 0.6 inch.

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When the Engineer determines that thickness-deficient areas warrant removal, remove and replace those areas with concrete having thickness indicated in the contract documents. Replacement pavement will be in accordance with requirements of Subsection 411.03(T) - Pavement Thickness and this subsection.

When profile index does not exceed 10, the Engineer will pay for the accepted pavement. When profile index exceeds 10, but less than or equal to 15, the Contractor may elect to accept a reduced price adjustment as determined by the Engineer in lieu of reducing profile index. Profile index over 15 shall require corrective work.

The Engineer at its sole digression determines an adjusted price using planned thickness of PCC pavement. Adjusted price will apply to total area of the 0.1-mile section for lane width represented by profilogram.

END OF SECTION 411