

## SECTION 416 CONCRETE PAVEMENT - APPURTENANT CONSTRUCTION

### 416.1 Description

- (1) This section describes constructing concrete driveways; truck aprons for roundabouts; drilling in tie bars to tie existing to new concrete and drilling in dowel bars to transfer load between existing and new concrete; concrete surface drains; concrete rumble strips; and concrete pavement repair and replacement.

### 416.2 Materials

#### 416.2.1 General

- (1) Furnish air-entrained concrete conforming to [section 501](#) as modified for class II concrete in [section 716](#). Provide QMP for class II ancillary concrete as specified in [section 716](#).
- (2) Furnish high early strength concrete under the HES bid items. The contractor may use HES concrete even where the contract does not require it.
- (3) Furnish calcium chloride for concrete placed under SHES bid items as follows:
  1. For use in solid form or on the job preparation of admixture solutions, conform to AASHTO M144, type S, grade 1 or grade 2.
  2. For admixture delivered in premixed solution form, conform to AASHTO M144, type L, in a concentration of approximately 30 percent.

#### 416.2.2 Concrete Driveways, Truck Aprons, and Surface Drains

- (1) Use grade A, A2, A3, A-FA, A-S, A-S2, A-T, A-IS, or A-IP concrete as specified in [section 501](#).
- (2) Color concrete red conforming to [section 405](#) for roundabout truck aprons.

#### 416.2.3 Tie bars and Dowel bars

##### 416.2.3.1 General

- (1) Furnish tie bars and dowel bars conforming to [505.2.6](#).

##### 416.2.3.2 Epoxy

- (1) Furnish epoxy consisting of a 2-component epoxy material of contrasting colors and conforming to AASHTO M235, grade 3 - non-sagging consistency, type IV epoxy, except as modified below:
  1. Use class B material for mid-depth slab temperatures between 40 F and 60 F.
  2. Use class C material for mid-depth slab temperatures between 60 F and the highest temperature allowed by the manufacturer of the product.
- (2) Bond strength, tensile strength, and elongation testing is not required.
- (3) Achieve a minimum compressive yield strength of 5000 pounds per square inch at 8 hours for special high early strength concrete, or at 3 days for grades A, C, and E concrete. Test according to AASHTO M235 and ASTM D695, with the following restrictions:
  1. Mold and cure compressive test specimens in cylinders with a one-inch nominal diameter.
  2. Machine specimen ends square to produce a final specimen length of 2 inches.
- (4) Before using the epoxy submit a manufacturer's certificate of compliance, and a certified report of test or analysis from a qualified independent laboratory, to the engineer certifying that the epoxy conforms to these specifications. Identify the temperature classes and compressive strength cure times for which the product is certified.

#### 416.2.4 Concrete Pavement Repair and Replacement

- (1) Except as specified in [416.3.6](#) for inlaid rumble strips, use grade C, C-FA, C-S, C-IS, or C-IP concrete as specified in [section 501](#).

#### 416.2.5 Special High Early Strength Concrete Pavement Repair and Replacement

##### 416.2.5.1 Composition and Proportioning of Concrete

- (1) For the concrete mixture, use a minimum of 846 pounds of cementitious material per cubic yard of concrete. Determine materials and proportions of the concrete mixture to obtain a minimum compressive strength in the concrete of 3000 pounds per square inch within 8 hours of placement. The contractor may add one or a combination of admixtures to the ingredients or to the mixture in order to obtain the required minimum strength and required air content. Do not retemper the concrete mixture.

- (2) Provide calcium chloride, if used in the mix, either as a pre-mixed solution or as a job-mixed solution. Ensure that job-mixed solutions contain 1.0 pounds per quart of 77 percent calcium chloride or 0.9 pounds per quart of 90 percent calcium chloride. Do not exceed the manufacturer's recommended maximum dosage. If the engineer requests, provide a written copy of the manufacturer's dosage recommendations.
- (3) Add calcium chloride, in solution, by an engineer-approved procedure to the batch ingredients while placing them in the mixer. Provide sufficient water in job-mixed solutions to dissolve the calcium chloride completely, and ensure that the solution is of a uniform and known concentration. Reduce the quantity of mixing water by the quantity of solution used. Introduce the correct quantity of calcium chloride into the mixer using a method by which the quantity added cannot vary appreciably from the target value.
- (4) Discharge all concrete within 45 minutes after adding mixing water to the cement, or the cement to the aggregates, or within 30 minutes after adding an accelerating admixture, whichever comes sooner.

#### **416.2.5.2 Evaluating Strength**

- (1) At least 3 business days before starting construction, provide the engineer with adequate evidence that the required strength is obtainable in the field with the materials used and at the various temperatures encountered. Conduct a continued strength evaluation, if the engineer requires, during the course of the work to ensure continued compliance with the strength requirements.
- (2) Notify the engineer before making test cylinders and, if the engineer chooses, make arrangements for the engineer to observe cylinder production. Use a department qualified laboratory and HTCP certified technician to conduct preliminary and continued strength evaluations. Base each reported value on a minimum of 2 cylinders. After submitting data showing obtainment of the required strength, do not change the mix without first submitting a complete new set of test data showing compliance with the requirements.

### **416.3 Construction**

#### **416.3.1 General**

- (1) The engineer will inspect ancillary concrete, as defined in [416.5.2](#) and built under section 416, for transverse cracking as specified in [415.3.17](#). Repair cracked concrete as the engineer directs.

#### **416.3.2 Concrete Driveways and Truck Aprons**

- (1) Construct concrete driveways and truck aprons conforming to [415.3](#) except the contractor may use engineer-approved wood or plastic forms. Color concrete for roundabout truck aprons red as specified in [section 405](#).

#### **416.3.3 Placing Tie Bars in Existing Concrete**

##### **416.3.3.1 Force Driven**

- (1) Drill a suitably sized hole into the edge of the existing concrete. Force drive the tie bar to a depth of 6 inches into the prepared hole as the plans show.

##### **416.3.3.2 Epoxied**

- (1) Drill holes into the edge of the existing concrete to the dimensions the plans show. Anchor the tie bars into the existing concrete with an epoxy conforming to [416.2.3.2](#) and install conforming to [416.3.4](#) except no bond breaker is required.

#### **416.3.4 Placing Dowel Bars in Existing Concrete**

- (1) Drill holes into the edge of the existing concrete to the dimensions the plans show. Anchor the dowel bars into the existing concrete with an epoxy conforming to [416.2.3.2](#).
- (2) Clean drilling dust, debris, and excess moisture from drill holes before inserting the epoxy and dowel bar.
- (3) Inject the epoxy into the back of the drill hole. Use an epoxy with a workable viscosity, pumpable, yet thick enough to remain in the hole. Insert a sufficient volume of epoxy into the hole to provide a small quantity of excess material at the face of the concrete after fully inserting the dowel.
- (4) Insert dowel bars in the drill holes and rotate 1/2 turn. Do not force drive dowel bars into the drill holes.
- (5) Completely fill the annular space between the dowel bar and the concrete with epoxy. Insert a retaining ring over the bar, and push the ring flush against the concrete surface to retain the epoxy.
- (6) Coat the protruding portion of each dowel bar with a thin uniform layer of bond breaking lubricant.

- (7) Use a positive fixed displacement dispensing system, equipped with a nozzle of sufficient length to deposit the epoxy at the back of the drilled hole. Use a system equipped with a means of checking the mix ratio of the epoxy components. Use the manufacturer's recommended mix ratio and check the ratio at least once a day.
- (8) For minor quantities of dowel bars, the contractor may use hand-powered mixing and injecting equipment capable of thoroughly mixing and depositing the epoxy at the back of the drill hole.

#### **416.3.5 Surface Drains**

- (1) Install and maintain temporary surface drains at locations designated for permanent drains until permanent drains are completed.
- (2) Place and secure steel reinforcement and tie bars in in their plan position before placing concrete. Place and cure the concrete conforming to [415.3](#).
- (3) Excavate, prepare the subgrade and aggregate base, and backfill as required to place the drains and restore the grade after placement.

#### **416.3.6 Concrete Rumble Strips**

- (1) Mill shoulder rumble strips into new or existing concrete shoulders. Mill or form intersection rumble strips into new concrete pavement or, if inlaid into existing HMA or concrete pavements, into work built under the Concrete Pavement Replacement bid item except use concrete conforming to [416.2.2](#). Do not apply rumble strips across bridges.
- (2) If milling, use a rotary head mill with a cutting tip pattern that will produce a relatively smooth cut of the size, shape, spacing, and alignment the plans show. Ensure that cutting heads are on a suspension independent from the power unit to allow the heads to self-align with slopes and irregularities. Also ensure that the machine has a guidance system that consistently provides the plan alignment of the rumble strips.
- (3) If forming rumble strips into freshly placed concrete, form or finish the concrete to consistently produce the size, shape, spacing, alignment, and smoothness the plans show.
- (4) Before beginning the work, demonstrate to the engineer that the proposed operation achieves the desired surface inside each depression without damaging the pavement. Place rumble strips in the pattern and shape the plans show. For shoulders carrying temporary traffic during construction, do not install rumble strips until after routing traffic back to the mainline.

***Revise 416.3.6(5) to prohibit sweeping rumble strip millings onto newly place finished shoulders.***

- (5) At the end of each work day, move equipment and material out of the clear zone and sweep or vacuum the traveled way pavement and shoulder areas. Sweep away or vacuum up milling debris before opening adjacent lanes to traffic. Dispose of waste material as specified in [203.3.4](#); **do not place on the finished shoulder surface.**

#### **416.3.7 Concrete Pavement Repair and Replacement**

- (1) Repair concrete pavement at the locations the plans show or where the engineer directs. Conform to the pavement repair plan details. For individual repair areas at least one lane wide and greater than 15 feet up to 100 feet long, conform to the pavement replacement plan details.
- (2) Construct conforming to the following:
  - Remove concrete pavement, remove asphaltic patch, and prepare the base as specified under [416.3.8.1](#).
  - Place concrete in repair areas as specified under [416.3.8.2](#). Disregard the same-day requirements for completion of curing and opening to traffic and instead conform to [415.3.12](#) through [415.3.15](#).
  - Place concrete in replacement areas conforming to [416.3.8.3](#) except disregard the same-day requirements for completion of curing and opening to traffic.

#### **416.3.8 Special High Early Strength Concrete Pavement Repair and Replacement**

##### **416.3.8.1 General**

- (1) Repair concrete pavement at the locations the plans show or where the engineer directs. Conform to pavement repair plan details. For individual repair areas at least one lane wide and 15 feet to less than 100 feet long, conform to pavement replacement plan details.

#### **416.3.8.1.1 Removing Concrete Pavement**

- (1) Remove deteriorated slabs without damaging adjacent pavement. If removing only a portion of an existing slab, make a straight full lane-width full depth saw cut to facilitate removal without damaging the remaining pavement. Ensure that repair areas in adjacent lanes match longitudinally.
- (2) If the contractor damages pavement designated to remain in place, repair damaged pavement as the concrete pavement repair and replacement details show. Ensure that the length of the damage repair and the adjacent planned repair are the same and both are a full lane wide. If damage is done to pavement not adjacent to a planned repair, conform to the minimum removal length the repair and replacement details show and remove and repair the full lane width.
- (3) Remove concrete with minimal disturbance to the aggregate base. At the close of each day's work, ensure that all slabs have been removed from the project limits and stored away from the roadway. Incorporate or dispose of removed pavement as specified in [203.3.4](#).
- (4) Replace areas of the asphaltic shoulder removed during these pavement removal operations to the elevation of the adjacent shoulder using a commercially produced asphaltic patching material. Before patching, clean, dry, and provide a uniform edge for the repair area.

#### **416.3.8.1.2 Removing Asphaltic Patches**

- (1) Remove existing asphaltic patches. Saw back the existing pavement full depth in an area of sound concrete as the plans show.

#### **416.3.8.1.3 Base Course**

- (1) Place the concrete on existing base course shaped to the required cross section. Remove concrete rubble and foreign material with minimal disturbance of the base.
- (2) Fill low areas or depressions in the base following removal operations with either compacted aggregate base or additional concrete.

#### **416.3.8.2 Placing Concrete in Repair Areas**

- (1) Place, cure, and open special high early strength concrete to traffic on the same day removing the old pavement. Place each repair in one continuous, full depth operation. Consolidate the concrete in place using an immersion type vibrator. Finish the surface by screeding twice, floating, and texturing. Operate the screed parallel to the pavement centerline, unless the repair is over 12 feet in length.
- (2) Make the transverse edges of the finished repair flush with the edges of the existing concrete pavement. Make the longitudinal surface form a straight line from edge to edge with a tolerance of +/- 1/8 inch.
- (3) Finish the final surface of the full depth concrete repair to match the edge of existing HMA or concrete pavement and, if the abutting pavement is concrete, match the existing pavement texture.

#### **416.3.8.3 Placing Concrete in Replacement Areas**

- (1) Place, cure, and open special high early strength concrete to traffic by sunset on the same day removing the old pavement. Place each repair in one continuous, full-depth operation conforming to [415.3.6](#) through [415.3.15](#) except date each replacement slab with the month and year of construction.

#### **416.4 Measurement**

- (1) The department will measure the Concrete Driveway bid items by the square yard acceptably completed, as specified in [415.4](#) for Concrete Pavement. The department will only measure area outside the specified limits for the pavement, curbs, gutters, combination curb & gutter or other structures.
- (2) The department will measure the Concrete Roundabout Truck Apron bid items by the square yard acceptably completed.
- (3) The department will measure the Drilled Tie Bars and Drilled Dowel Bars bid items as each individual bar acceptably completed.
- (4) The department will measure the Concrete Surface Drains bid items by the cubic yard acceptably completed, based on the dimensions the plans show or the engineer directs.
- (5) The department will measure Concrete Rumble Strips Shoulder by the linear foot acceptably completed, measured as the length along each side of the traveled way from the center of the first groove in a segment to the center of the last groove in that segment. The department will not deduct for skips at transverse joints less than or equal to the minimum the plans show.

- (6) The department will measure Concrete Rumble Strips Intersection by the square yard acceptably completed, measured to include the area between the milled or cast-in-place grooves, or if inlaid into existing HMA or concrete pavement, the area of the inlay. The department will not deduct the area of embedded fixtures with an area of one square yard as measured in the plane of the pavement surface.
- (7) The department will measure the Concrete Pavement Repair and Concrete Pavement Replacement bid items by the square yard acceptably completed.

**416.5 Payment**

**416.5.1 General**

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
416.0160 - 0199	Concrete Driveway (inch)	SY
416.0260 - 0299	Concrete Driveway HES (inch)	SY
416.0508 - 0520	Concrete Roundabout Truck Apron (inch)	SY
416.0610	Drilled Tie Bars	Each
416.0620	Drilled Dowel Bars	Each
416.1010	Concrete Surface Drains	CY
416.1015	Concrete Surface Drains HES	CY
416.1110	Concrete Rumble Strips Shoulder	LF
416.1180	Concrete Rumble Strips Intersection	SY
416.1710	Concrete Pavement Repair	SY
416.1715	Concrete Pavement Repair SHES	SY
416.1720	Concrete Pavement Replacement	SY
416.1725	Concrete Pavement Replacement SHES	SY

- (2) The department will pay for the Concrete Driveway and Concrete Roundabout Truck Apron bid items as specified in [415.5.1](#) and [415.5.2](#) for Concrete Pavement. The department will pay separately for coloring concrete as required for roundabout truck aprons under the Coloring Concrete Red bid item.
- (3) Payment for Drilled Tie Bars is full compensation for providing tie bars, including coating; for drilling holes in concrete not placed under the contract; and for epoxying or driving.
- (4) Payment for Drilled Dowel Bars is full compensation for providing dowel bars, including coating; for drilling holes in concrete not placed under the contract; and for epoxying.
- (5) Payment for the Concrete Surface Drains bid items is full compensation for providing surface drains; for steel reinforcement and dowel and tie bars; and for excavating, preparing the subgrade and aggregate base, and backfilling.
- (6) Payment for Concrete Rumble Strips Shoulder is full compensation for milling; for sweeping or vacuuming; and for disposing of waste materials.
- (7) Payment for Concrete Rumble Strips Intersection is full compensation for milling or forming grooves; for sweeping or vacuuming; and for disposing of waste materials. The department will pay separately for new concrete pavement under the Concrete Pavement bid items; and for concrete inlaid in existing HMA or concrete pavement under the Concrete Pavement Replacement bid item.
- (8) Payment for the Concrete Pavement Repair and the Concrete Pavement Replacement bid items is full compensation for furnishing, hauling, preparing, placing, curing, and protecting materials; for replacing damaged pavement designated to remain in place; for removing and disposing of existing pavements and excavated materials; for repairing asphaltic shoulders; for sawing joints; for preparing the foundation; for backfilling; and for testing concrete cylinders. The department will pay for individual repairs at least one lane wide and greater than 15 feet and up to 100 feet long as Concrete Pavement Replacement. Payment includes jointing and providing tie bars and dowel bars in unhardened concrete. The department will pay separately for associated work as follows:
  - For tie bars and dowel bars provided in concrete not placed under the contract, exclusive of those necessary to repair contractor-caused damage, under the Drilled Tie Bars and Drilled Dowel Bars bid items.
  - For sawing existing concrete for removal, under the Sawing Concrete bid item as specified in [690.5](#).

- For repairs 100 feet long or longer, under the Removing Pavement bid item as specified in [204.5](#) and the Concrete Pavement bid items as specified in [415.5](#).

**416.5.2 Adjusting Pay for Ancillary Concrete Crack Repairs**

- (1) The department will adjust pay for crack repairs on ancillary concrete. Ancillary concrete includes curb & gutter whether separately or integrally placed, curb, gutter, medians, sidewalks, loading zones, safety islands, steps, concrete surface drains, truck aprons, and driveways. The engineer will allocate responsibility and costs for crack repairs, mobilization for traffic control, and traffic control devices, according to [CMM 4-24](#). The department will adjust pay under the Crack Repair Ancillary Concrete administrative item.
- (2) Pay adjustment for crack repair costs includes mobilization for the repair work; sawing; removals; furnishing and placing all materials including dowel bars and steel reinforcement; drilled tie and dowel bars; and all incidentals. The engineer will compute the pay adjustment for repair costs as the contract unit price for the item, times the quantity replaced, multiplied by the appropriate multiplier as follows:

**COMPUTED AMOUNT MULTIPLIER PER QUANTITY FOR ANCILLARY CONCRETE**

ITEM REPLACED	SHARED REIMBURSEMENT MULTIPLIER	TOTAL REIMBURSEMENT MULTIPLIER
Quantity replaced	6	12

- (3) The department will adjust pay for traffic control devices and mobilization for traffic control separately.