Item No. 439	Continuously reinforced concrete pavement, Class 3	Concrete _____ in (mm) thick	Per square yard (meter)
Item No. 439	Continuously reinforced concrete pavement, Class HES	Concrete _____ in (mm) thick	Per square yard (meter)

439.5.01 Adjustments

A. Profilograph Tests

If based on the Department's profilograph tests, the Engineer determines that the Contractor profilograph test results are inaccurate, the Contractor will be charged for profilograph testing at $500 for each trace mile ($250 for each trace kilometer) with a minimum charge of $500.

Section 440—Plain Portland Cement Concrete Shoulders

440.1 General Description

The work includes constructing plain Portland cement concrete shoulders on a prepared subgrade or subbase according to these Specifications. Construct the shoulders to conform with lines, grades, thicknesses, and cross sections shown on the Plans or established by the Engineer.

440.1.01 Definitions

General Provisions 101 through 150.

440.1.02 Related References

A. Standard Specifications

Section 430—Portland Cement Concrete Pavement

Section 461—Sealing Roadway and Bridge Joints and Cracks

Section 500—Concrete Structures

Section 815—Graded Aggregate

Section 830—Portland Cement

B. Referenced Documents

AASHTO T 22

AASHTO T 23

ASTM C 94, Requirements for Uniformity

AASHTO T 97

AASHTO T 126

GDT 26

GDT 27

GDT 28

GDT 32

440.1.03 Submittals

A. Concrete Mix Design

Submit to the Engineer a concrete mix design prepared by a qualified testing laboratory. The Engineer will transmit the design to the Office of Materials and Research for approval. Ensure that the concrete mix design conforms to Subsection 440.2.A, "Composition of Class SP Concrete."

440.2 Materials

Use materials that conform to Subsection 430.2, "Materials," for Portland cement concrete pavement, or Subsection 815.2.01 for graded aggregate. Gradation requirements are modified to require 30 to 45 percent by weight to pass the No. 10 (2 mm) sieve for graded aggregate.

A. Composition of Class SP Concrete

Ensure that the concrete mix design conforms to the following requirements:

1. Aggregates
   a. Shoulders Not Constructed In Continuity With Travel Lanes
      1) Graded Aggregate meeting the requirements in Subsection 815.2.01 and as modified in Subsection 440.2, "Materials" may by used if the shoulders are not constructed in continuity with travel lanes.
      2) Graded aggregate may be used as the coarse and fine aggregate portions of the concrete mix except that the gradation is modified to require 30 to 45 percent passing the No. 10 (2 mm) sieve.
      3) Use aggregates manufactured to meet the gradation at the quarry or blended at the plant site to produce the desired results. Ensure a uniform aggregate gradation when charging the mixer.
   b. Shoulders Constructed in Continuity with Travel Lanes

      Use concrete aggregate in shoulders constructed in continuity with travel lanes as specified in Subsection 430.2.C, "Composition of Concrete" and Subsection 430.2.C.2, "Fine Aggregate".
2. Mix Design Criteria

   Base the proportions of Class SP concrete mix designs on the following requirements:

	Minimum Cement Content per Cubic Yard (meter) Concrete CWT (kg)	Maximum Water-Cement Ratio lbs/lb (kg/kg)	Design Air Content Range (%)
Class SP Concrete	4.25 (250)	0.75 (0.75)	5.0 to 7.0

3. Fly Ash

   Use fly ash as an additive in concrete to promote workability and plasticity or as a partial replacement for Portland cement if the following limits are met:
   a. Replace the cement quantity no more than 15 percent by weight.
   b. Replace cement with fly ash at the rate of 1.25 to 2 lbs (1.25 to 2.0 kg) of fly ash to 1 lb (1.0 kg) of cement.
   c. Do not use type IP cement in fly ash mixes.

   Calculate the water-cement ratio based on the total cement material in the mix including fly ash.

   Construct Portland cement concrete shoulders with the same class of concrete required in the adjacent sections when constructed in continuity with travel lanes, ramps, acceleration lanes, deceleration lanes, or other sections.

   Produce evidence that the proportions have the potential for strength development at 28 days as required in Subsection 440.3.06.B, "Approval of Mix Design Proportions".

440.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

440.3 Construction Requirements

440.3.01 Personnel

General Provisions 101 through 150.

440.3.02 Equipment

Use equipment that meets the requirements in Subsection 430.3.02, "Equipment."

440.3.03 Preparation

Prepare the roadbed as required by the Plans and Specifications before placing the concrete shoulder.

Ensure that the foundation immediately under the concrete shoulder and the areas supporting the paving equipment will not contribute to deficient shoulder thicknesses or excessive yield losses.

440.3.04 Fabrication

General Provisions 101 through 150.

440.3.05 Construction

A. Placing Concrete

Place concrete as follows:

1. Deposit the concrete on the grade; do not rehandle it if possible.
2. Unless truck mixers, truck agitators, or non-agitating hauling equipment are equipped to discharge concrete without segregation, concrete shall be unloaded into an approved spreading device and mechanically spread on grade.
3. Place it continuously between transverse joints without using the intermediate bulkheads.
4. Perform any necessary hand spreading with shovels.

NOTE: Do not allow personnel to walk in freshly mixed concrete with shoes coated with harmful substances.

5. Thoroughly consolidate with vibration the concrete against and along the form faces and along the full length and both sides of joint assemblies.
6. Do not continue vibration if puddling or excessive grout accumulates on the surface.

NOTE: Do not use grout that accumulates ahead of the paver in construction or expansion joints.

7. Deposit concrete near formed joints. Do not dump or discharge concrete onto a joint assembly unless the concrete is centered on the joint assembly.

B. Placing Reinforcement

Place the reinforcement according to details on the Plans. Do not allow reinforcement placement to disrupt or damage the concrete. Do not insert lane tie bars into unsupported sides of fresh concrete.

C. Achieving Consolidation

Vibrate the full width and depth of the shoulder. Do not allow the vibrators to contact the foundation, load transfer devices, side forms, or joints.

If the vibrator does not produce uniform consolidation and density, stop the operation to furnish methods or equipment that will produce pavement according to the Specifications.

D. Finishing

Finish the concrete pavement as follows:

1. Smooth and true the concrete to the proper cross-section with hand floats or mechanical floats.
2. Ensure that the surface conforms to the required cross section and contains no irregular, rough, or porous areas.
3. Make the surfaces flush at the joint between the roadway and shoulder.
4. Finish the surface to provide a uniform texture in all areas except rumble strips. Use mechanical equipment for grooving plastic concrete, brooming, or burlap drag.
5. Form rumble strips in the shoulder surface according to the Plans.

E. Cleaning Up

Immediately after finishing, remove the loose material and clean the grout from the surface of adjacent lanes.

F. Constructing Joints

Use the joint, type of filler, and type of sealer designated in the Plans.

Construct joints according to Subsection 430.3.05.J, “Provide Joints,” Section 461, and the following:

1. Transverse Contraction Joints

   Saw transverse contraction joints in the shoulder to abut like joints in the roadway, or construct joints as shown on the Plans.

2. Longitudinal Joints
   a. On the longitudinal joint adjacent to the adjoining lane, place reinforcement at locations shown on the Plans.
   b. Secure the reinforcement in place with supporting assemblies or by inserting into supported sides of fresh concrete, or by using mechanical equipment to insert them while placing concrete.
3. Construction Joints

   Form transverse construction joints when concreting operations will be interrupted for more than 1 hour. Construct the joint according to Subsection 430.3.05.K.5, "Construction Joints," except stringline requirements are 1/4 in (6 mm) maximum deviations in 15 ft (4.5 m).

G. Curing

Cure concrete according to Subsection 430.3.05.L, "Cure the Concrete."

H. Permitting Traffic on Shoulders

Before using a shoulder as a haul road for loaded or unloaded vehicles:

1. Ensure that compressive strength tests show the concrete has developed at least 2,000 psi (14 MPa) and is at least 7 days old.
2. Construct earth ramps to facilitate movement across the shoulder. Place barricades to prevent traffic encroachment.
3. Seal the joints before permitting vehicles or equipment on the shoulder.

440.3.06 Quality Acceptance

A. Concrete Mixing

Produce Portland cement concrete shoulders using Class SP concrete as follows:

1. Combine authorized proportions of approved materials in homogenous batches according to the construction methods in this Specification.
2. Mix concrete produced in a stationary central mix plant for at least 60 seconds after placing materials in the drum.
3. Reduction of the mix time may be allowed if representative tests show that the concrete meets requirements of ASTM C 94, Requirements for Uniformity, but never reduce the mix time to less than 50 seconds.
4. Ensure that transit mixed concrete meets requirements in Subsection 500.3.04.E.3, "Transit-Mixed Concrete."

B. Approval of Mix Design Proportions

The Office of Materials and Research will review concrete mix designs and will verify that compressive strength development is according to AASHTO T 126 and T 22.

The Department will approve material combinations and mix designs using approved materials and complying with Subsection 440.2.A, "Composition of Class SP Concrete," and the following:

1. Flexural Strength

   Take at least 5 normally cured flexural specimens to ensure that the 28-day laboratory flexural design strength is according to AASHTO T 126 and T 97 and is within the following design acceptance range (DAR).

Class SP Concrete DAR =400 psi ± .67s (2.8 MPa ± .67s)
where s = The standard deviation of 28-day flexural specimens for a combination of materials and mix proportions prepared together. Do not use a value of s greater than 37 psi (255 kPa) to calculate DAR.

   A mixture may be used that exceeds the upper limit of the DAR.

2. Compressive Strength

   Prepare and test 6 cylinders according to AASHTO T 126 and T 22 to determine the 28-day laboratory compressive strength for Class SP concrete. Ensure that it exceeds the following minimum laboratory performance value (LPV).

Class SP Concrete LPV = 2,000 psi + .18R (13.8 MPa + .18R)
where R = The difference between the largest observed value and the smallest observed value for 28-day compressive strength specimens for a combination of materials and mix proportions prepared together.

C. Field Adjustments on Concrete Mixes

Determine the aggregate surface moisture and apply free moisture corrections to the approved mix design. The Engineer will verify that these corrections are made properly.

Adjustments to the approved proportions of the fine aggregate, coarse aggregate, and water may be made according to these guidelines:

- Do not decrease the cement factor.
- Do not increase the water-cement ratio.
- Ensure that adjustments produce concrete proportions according to this Specification.
- Notify the Engineer before making adjustments.

D. Concrete Mix Tolerances

Ensure that variations in consistency and concrete air content are within the following limits:

1. Consistency

   Immediately before placing, determine concrete slump using GDT 27. Concrete for Portland cement concrete shoulders will not be accepted if the slump value is greater than 3 in (75 mm).

2. Air Content

   Determine the concrete air content immediately before placement using GDT 26 or GDT 32.

   Concrete will not be accepted with an air content outside the following limits:

Lower acceptance limit	3.0 percent
Upper acceptance limit	7.5 percent

E. Acceptance of Concrete Strength

Portland cement concrete shoulder strength shall be accepted based upon its 28-day compressive strength development.

1. Subdivide the shoulder into separate lots of approximately 7,000 yd² (5850 m²) of concrete shoulder placed continuously, except for overnight or other minimal discontinuance.
2. Randomly select three production units from each lot for strength determination tests.
3. Cast one set of cylinders for each production unit being tested.
4. A set consists of two 6 by 12 in (150 by 300 mm) cylinders cured according to AASHTO T 23. The test is the average strength of the two cylinders tested according to AASHTO T 22.
5. Determine lot strength acceptance according to the limits in the Pay Factor Schedule for Strength Determinations at 28 Days table.
   a. If the average strength of the lot, based on the three acceptance tests, does not meet the lower acceptance limit shown in the 1.00 pay factor, the Contractor may leave the lot in place at a reduced Unit Price according to the Pay Factor Schedule for Strength Determinations at 28 Days.
   b. If the average strength of the lot does not attain the lower acceptance limit shown for a 0.70 pay factor, the Engineer may order the removal of any or all of the concrete in the lot.

Pay Factor Schedule for Strength Determinations at 28 Days			
Acceptance Limits for Pay Factor Levels			
	1.00 LAL*	0.95 LAL	0.70 LAL
Class SP Concrete	2000 psi (13.8 MPa)+ 0.18 R	2000 psi (13.8 MPa) - 0.07 R	2000 psi (13.8 MPa) - 0.30 R
* Lower Acceptance Limit (LAL)			

The pay factor is 0.50 for concrete that remains in place when outside the 0.70 pay factor limits for compressive strength.

F. Thickness Tolerances

Determine the thickness by measuring the fresh concrete depth at the shoulder edges at least every 500 ft (150 m) of shoulder length.

The Engineer will evaluate areas deficient by more than 1 in (25 mm) thick. If the Engineer requires removal, remove and replace the shoulder pavement in full cross sections according to Plan requirements.

If removal and replacement are not required, payment is made at 50 percent of the Contract Unit Price for areas deficient by more than 1 in (25 mm). Areas that are deficient by more than 0.5 in (13 mm) through 1 in (25 mm) will be paid for at 70 percent of the Contract Price per square yard (meter).

440.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

440.4 Measurement

The work to be paid for under this Item is the number of square yards (meters) of Portland cement concrete shoulders completed and accepted as measured in place. The measurement width is the shoulder width shown on the Plan typical cross-section. The measurement length is along the surface at the inside edge of the paved shoulder.

440.4.01 Limits

General Provisions 101 through 150.

440.5 Payment

The work will be paid for at the Contract Unit Price per square yard (meter). Payment is full compensation for providing materials, reinforcement, equipment, and labor, mixing, hauling, handling, placing, and providing incidentals to complete the work.

Payment will be made under:

Item No. 440	Plain Portland cement concrete shoulders, type___	Per square yard (meter)

440.5.01 Adjustments

The Contract Unit Price per square yard (meter) of concrete shoulder will be adjusted for concrete shoulder accepted with a 28-day compressive strength or thickness deficiency.

If a shoulder section is deficient in thickness and compressive strength, the Contract Unit Price will be adjusted by the total reduction of the application of the two individual percentages shown in the Pay Factor Schedule and Subsection 440.3.06.F, "Thickness Tolerances."

For combined deficiencies of 50 percent or more, the Engineer may allow the shoulder to stay in place or require its removal. If the Engineer requires shoulder pavement removal, the original pavement nor its removal will be paid for. Pavement replaced satisfactorily will be paid for at the appropriate Unit Price.

Section 441—Miscellaneous Concrete

441.1 General Description

This work includes placing Portland cement concrete as follows:

- As slope paving on end rolls, cut slopes, paved ditches, spillways, and ditch slopes
- In median pavement
- As sidewalks
- In concrete curbs, gutters, curb and gutters, and valley gutters
- As nonreinforced headwalls
- As velocity dissipators and concrete slope drains
- As concrete spillways
- Curb cut wheel chair ramps