715 QMP Concrete Pavement, Cast-in-Place Barrier and Structures

715.1 Description

(1) This section describes contractor mix design, testing, and documentation requirements for class I concrete used in concrete structures, cast-in-place concrete barrier, and concrete pavement.

715.1.1 Quality Control Program

715.1.1.1 General

(1) Conform to general requirements under 701 and 710 as well as additional requirements for class I concrete specified here in section 715. The department defines class I concrete as cast-in-place concrete used in pavement, barrier, or structure applications where all of the following apply:

- Mix design requires review by the engineer.
- The contract defines spec limits for strength.
- The contractor may earn statistically based incentives for superior concrete strength.[1]

[1] HES and SHES concrete are not eligible for 28-day strength incentives.

715.1.1.2 Small Quantities

(1) The department defines small quantities of class I concrete, subject to the reduced requirements under 710.2, as follows:

- Less than 250 cubic yards of structure concrete placed under a single bid item.
- Less than 150 cubic yards of barrier concrete placed under the contract.
- Less than 2500 cubic yards of slip-formed pavement placed under the contract.
- Less than 1000 cubic yards of non-slip-formed pavement placed under the contract.

715.1.1.3 Pre-Pour Meetings for Structure Concrete

(1) Arrange at least two pre-pour meetings to discuss concrete placement. Discuss the placement schedule, personnel roles and responsibilities, testing and quality control, and how test results will be communicated. Schedule the first meeting before placing any concrete and the second before placing any bridge deck concrete. Ensure that representatives from all parties involved with concrete work, including contractor, sub-contractor, ready-mix supplier, testers, and the project manager, attend these meetings.

715.1.1.4 Quality Control Plan

(1) Submit a quality control plan 7 business days before producing concrete, conforming to 701.1.2.2 and include the following:

1. Concrete mix design documentation as required in 710.4.
2. Proposed methods for monitoring and recording batch weights.
3. Aggregate gradation acceptance method for class I concrete items.
4. Methods for monitoring and adjusting blended aggregate gradations before corrective action is required under 710.5.7; and methods for documenting corrective action.

715.1.1.5 Documentation

(1) Submit results electronically into MRS within 5 business days after those results become available for the following, if required under the contract:

- QC tests.
- Engineer-directed tests.
- Corrective-action tests.

(2) Submit aggregate gradation test results as specified in 710.5.6.1(2).

715.2 Materials

715.2.1 General

(1) Determine mixes for class I concrete used under the contract using one or more of the following methods:

- Have a HTCP-certified PCC technician II develop new concrete mixes qualified based on the results of mix development tests performed by a department-qualified laboratory.

(2) The contractor need not provide separate laboratory mix designs for high early strength concrete nor provide routine 28-day compressive strength tests during placement for high early strength concrete.

(3) In addition to the mix information required under 710.4, at least 3 business days before producing concrete, submit the following to the engineer:

- Strength data from trial batching.

- Test dates of each trial batch.
- Name and location of laboratory that performed the trial batching.

(4) The engineer will review the submitted mix design within 3 business days of receiving the mix design submittal and complete Project Staff Review section of mix design certification within DT2220 or DT2221.

715.2.2 Class I Concrete Mixes

715.2.2.1 Pavements and Cast-in-Place Barrier

(1) Use at least 3 pairs of cylinders from 3 separate trial batches to demonstrate the compressive strength of a mix design.

(2) For concrete pavement, also demonstrate the flexural strength of the mix design using at least 3 pairs of beams from 3 separate trial batches.

(3) Demonstrate that the strength or the 28-day flexural strength of the proposed mix will equal or exceed the following:

- For pavement: the 85 percent within limits criterion specified in 715.5.2.
- For barrier: the 90 percent within limits criterion specified in 715.5.3.

(4) Use a SCM as a partial replacement for cement as specified in 501.3.2.2.2.

(5) Ensure that the target ratio of net water to cementitious material for the submitted mix design does not exceed 0.42 by weight. Include free water on the aggregate surface but do not include water absorbed within aggregate particles. Control the w/cm ratio throughout production by adjusting batch weights for changes in the aggregate moisture as required under 715.3.3.

(6) Do not use chloride-based accelerators in mixes for new construction.

715.2.2.2 Structures

(1) Qualify compressive strength according to ACI 301 - Specifications for Structural Concrete - subsections 4.2.3.1 through 4.2.3.4. Demonstrate that the 28-day compressive strength of the proposed mix will equal or exceed the 90 percent within limits criterion specified in 715.5.3.

(2) Provide grade A concrete with SCM as a partial replacement for cement as specified in 501.3.2.2.2.

(3) Ensure that the target ratio of net water to cementitious material (w/cm) for the submitted mix design does not exceed 0.45 by weight. Include free water on the aggregate surface but do not include water absorbed within aggregate particles. Control the w/cm ratio throughout production by adjusting batch weights for changes in the aggregate moisture as required under 715.3.3.

(4) Do not use mixes containing accelerators, except the contractor may use mixes containing non-chloride accelerators in substructure elements.

715.3 Testing and Acceptance

715.3.1 Class I Concrete Testing

715.3.1.1 General

(1) Test slump, air content, concrete temperature and concrete strength as specified in 710.5. Conduct a battery of QC tests for each specified property, using a single sample randomly located within each sublot. If a sublot random test location falls within a mainline pavement gap, relocate the test to a different location within the sublot. Cast three specimens for strength evaluation.

715.3.1.1.1 Flexural Strength

(1) For contracts with 50,000 square yards or more of concrete pavement, cast a set of 3 beams instead of cylinders for flexural strength acceptance testing at 28 days.

715.3.1.1.2 Surface Resistivity

(1) Cast a set of 3 additional 6"x12" cylinders and test the concrete surface resistivity according to WTM T358. Submit the resistivity to the nearest tenth into MRS for information only. Perform this testing at least once per lot if total contract quantities are greater than or equal to the following:

- 20,000 square yards for pavements.
- 5,000 linear feet for barriers.
- 500 cubic yards for structure concrete.

Resistivity testing is not required for the following:

- Lot with less than 3 sublots.
- Concrete items classified as ancillary.
- Concrete placed under the following bid items:

- Concrete Pavement Approach Slab
- Concrete Masonry Culverts
- Concrete Masonry Retaining Walls

715.3.1.2 Lot and Sublot Definition

715.3.1.2.1 General

(1) Designate the location and size of all lots before placing concrete. Ensure that no lot contains concrete of more than one mix design or placement method defined as follows:

Mix design change A modification to the mix requiring the engineer's approval under 710.4(4).

For paving and barrier mixes, a source change under item 1 of 710.4(4) for fly ash of the same class that does not require a modification under items 2 or 3 of 710.4(4) does not constitute a mix design change.

Placement method Either slip-formed, not slip-formed, or placed under water.

(2) Lots and sublots include ancillary concrete placed integrally with the class I concrete.

715.3.1.2.2 Lots by Lane-Feet

(1) The contractor may designate slip-formed pavement lots and sublots conforming to the following:

- Lots and sublots are one paving pass wide and may include one or more travel lanes, integrally placed shoulders, integrally placed ancillary concrete, and pavement gaps regardless of mix design and placement method used in the gaps.
- Sublots are 1000 feet long for single-lane and 500 feet long for two-lane paving. Adjust terminal sublot lengths to match the project length or, for staged construction, the stage length. The contractor may include sublots less than or equal to 25 percent of the standard length in the previous sublot. For partial sublots exceeding 25 percent of the standard length, notify the engineer who will direct additional testing to represent that partial sublot.
- Ensure that sublot limits match for adjacent paving passes. Pavement gaps do not affect the location of sublot limits.
- Create lots by grouping 5 adjacent sublots matching lots created for adjacent paving passes.

(2) If a sublot random test location falls in a pavement gap, test at a different random location within that sublot.

715.3.1.2.3 Lots by Cubic Yard

(1) Define standard lots and sublots conforming to the following:

TABLE 715-1 CLASS I - LOT AND SUBLOT SIZES

CONCRETE CLASSIFICATION	LOT SIZE	SUBLOT SIZE	NUMBER OF SUBLOTS PER LOT
Class I: Pavement	1250 cubic yards	250 cubic yards	5
Class I: Structures	250 cubic yards	50 cubic yards	5
Class I: Cast-in-Place Barrier	500 cubic yards	100 cubic yards	5

(2) The contractor may include sublots less than or equal to 25 percent of the standard volume in the previous sublot. For partial sublots exceeding 25 percent of the standard volume, notify the engineer who will direct additional testing to represent that partial sublot.

(3) An undersized lot is eligible for incentive payment under 715.5 if the lot has 3 or more sublots for that lot.

715.3.1.3 Department Verification Testing

(1) The department will perform verification testing once for each 5 contractor QC tests with additional testing as required to obtain at least 1 verification test per lot for air content, slump, temperature, and concrete strength.

(2) The department will report QV test results to the contractor within 2 business days after the department obtains the sample, or in the case of long-term testing, within 2 business days after conducting the test.

715.3.2 Strength Evaluation

715.3.2.1 General

(1) The department will make pay adjustments for strength on a lot-by-lot basis using the compressive strength of contractor QC cylinders or the flexural strength of contractor QC beams.

(2) Randomly select 2 QC specimens to test at 28 days for percent within limits (PWL). Compare the strengths of the 2 randomly selected QC specimens and determine the 28-day sublot average strength as follows:

- If the lower strength divided by the higher strength is 0.9 or more, average the 2 QC specimens.
- If the lower strength divided by the higher strength is less than 0.9, break one additional specimen and average the 2 higher strength specimens.

(3)The department will evaluate the sublot for possible removal and replacement if the 28-day sublot average strength is:

- Pavement (Compressive): < 2500 psi
- Pavement (Flexural): < 500 psi
- Structure: < f'c - 500 psi [1]
- Cast-in-Place Barrier: < f'c - 500 psi [1]

[1] f'c is design strength found in plans or specials.

715.3.2.2 Removal and Replacement

715.3.2.2.1 Pavement

(1) The department will direct the contractor to core the affected sub lot to determine structural adequacy. Timeframe of coring operations and locations will be agreed upon between department and contractor.

(2) Obtain three cores from the sublot in question. Perform coring according to WTM T24.

(3) Have an independent consultant test cores according to WTM T24.

(4) The department will assess concrete for removal and replacement based on a sublot-by-sublot analysis of core strength. Perform coring and testing, fill specimen voids with an engineer-approved non-shrink grout or concrete, and provide traffic control during operations.

(5) The pavement sublot will remain in place if the compressive strength of all cores from the sublot are 2500 psi or greater. The pavement 28-day QC average sublot strength will be included in the respective compressive or flexural strength PWL equation of 715.5.2 or 715.5.3.

(6) If the compressive strength of any core from the sublot is less than 2500 psi, the dearptment will direct the contractor to either:

1. Remove and replace unacceptable concrete pavement sublot ot the nearest joint with new concrete pavement of conforming strength. There is no incentive for replaced pavement, but the department will adjust pay for PWL values of < 85 according to 715.5.2 or 715.5.3. The department will pay once for the area at the full contract price.
2. Permit concrete pavement to remain in place. The original 28-day QC average sublot strength will be included in the relevant strength PWL equation of 715.5.2 or 715.5.3.

715.3.2.2.2 Structures and Cast-in-Place Barrier

(1) The department will direct the contractor to core the affected sublot to determine the structural adequacy. Timeframe of coring operations and locations will be agreed upon between department and contractor. Determine core locations that do not interfere with structural steel.

(2) Perform coring according to WTM T24.

(3) Have an independent consultant test cores according to WTM T24. The department will assess concrete for removal and replacement based on a sublot-by-sublot analysis of core strength. Perform coring and testing, fill voids with an engineer-approved non-shrink grout or concrete, and provide traffic control during operations.

(4) The sublot will remain in place if the 3-core average is greater than or equal to 85 percent of f'c, and no individual core is less than 75 percent of f'c. The 28-day QC average sublot strength will be included in the compressive strength PWL equation of 715.5.2.

(5) If the compressive strength of the 3-core average is less than 85 percent of f'c or an individual core is less than 75 percent f'c, the department will direct the contractor to either:

1. Remove and replace unacceptable structure or cast-in-place barrier sublot with new concrete of conforming strength. There is no incentive for replaced concrete, but the department will adjust

pay for PWL values < 85 according to 715.5.2. The department will pay once for the area at the full contract price.

2. Permit concrete to remain in place. The original 28-day QC average sublot strength will be included in the compressive strength PWL equation of 715.5.2.

715.3.3 Aggregate

715.3.3.1 General

(1) Except as allowed for small quantities in 710.2, test aggregate conforming to 710.5.6.

715.3.3.2 Structures

(1) In addition to the aggregate testing required under 710.5.6, determine the fine and coarse aggregate moisture content for each sample.

(2) Calculate target batch weights for each mix when production of that mix begins. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, adjust the batch weights to maintain the design w/cm ratio.

715.4 Measurement

(1) The department will measure the Incentive bid items under this section by the dollar, calculated as specified in 715.5.

715.5 Payment

715.5.1 General

(1) The department will pay incentive for concrete strength under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
715.0502	Incentive Strength Concrete Structures	DOL
715.0603	Incentive Strength Concrete Barrier	DOL
715.0715	Incentive Flexural Strength Concrete Pavement	DOL
715.0720	Incentive Compressive Strength Concrete Pavement	DOL

(2) Incentive payment may be more or less than the amount the schedule of items shows.

(3) The department will administer disincentives for strength under the Disincentive Strength Concrete Structures, Disincentive Strength Concrete Barrier, Disincentive Flexural Strength Concrete Pavement, and Disincentive Compressive Strength Concrete Pavement,administrative items.

(4) The department will adjust pay for each lot using PWL of the 28-day sublot average strengths for that lot. The department will measure PWL relative to strength lower specification limits as follows:

- Compressive strength of 3700 psi for pavements.
- Flexural strength of 650 psi for pavements.
- Compressive strength of 4000 psi for structures and barrier.

(5) The department will not pay a strength incentive for concrete that is nonconforming in another specified property, for ancillary concrete accepted based on tests of class I concrete, or for high early strength concrete unless placed in pavement gaps as allowed under 715.3.1.2.2.

(6) Submit test results to the department electronically using MRS software. The department will verify contractor data before determining pay adjustments.

(7) All coring and testing costs under 715.3.2.2 including filling core holes and providing traffic control during coring are incidental to the contract.

715.5.2 Pavements

715.5.2.1 Compressive

(1) The department will adjust pay for each lot using equation “QMP 3.01” as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per square yard)
>= 95 to 100	(0.1 x PWL) – 9.5
>= 85 to < 95	0
>= 30 to < 85	(1.5/55 x PWL) – 127.5/55
< 30	-1.50

(2) The department will not pay incentive if the lot standard deviation is greater than 400 psi compressive.

(3) For lots with a full battery of QC tests at less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average strength below 3700 psi by $1.50 per square yard.

(4) For integral shoulder pavement and pavement gaps accepted using test from the adjacent travel lane, the department will adjust pay using strength results of the travel lane for integrally placed concrete shoulders and pavement gaps regardless of mix design and placement method, included in lane-foot lot.

715.5.2.2 Flexural

(1) The department will adjust pay for each lot using equation "QMP 6.02" as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per square yard)
>= 95 to 100	(0.2 x PWL) - 19
>= 85 to < 95	0
>= 50 to < 85	(2.0/35 x PWL) - 170/35
< 50	-2.00

(2) The department will not pay incentive if the lot standard deviation is greater than 60 psi flexural.

(3) For lots with a full battery of QC tests at less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average flexural strength below 650 psi by $2.00 per square yard.

(4) For integral shoulder pavement and pavement gaps accepted using test from the adjacent travel lane, the department will adjust pay using strength results of the travel lane for integrally placed concrete shoulders and pavement gaps regardless of mix design and placement method, included in lane-foot lot.

715.5.3 Structures and Cast-in-Place Barrier

(1) The department will adjust pay for each lot using equation "QMP 2.01" as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per cubic yard)
>= 99 to 100	10
>= 90 to < 99	0
>= 50 to < 90	(7/8 x PWL) – 78.75
< 50	-35

(2) The department will not pay incentive if the lot standard deviation is greater than 350 psi compressive.

(3) For lots with less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average compressive strength below 4000 psi by $35 per cubic yard.