

715 QMP Concrete Pavement and Structures

715.1 Description

- (1) This section describes contractor mix design and testing 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 the general requirements under [701](#) and [710](#) as well as the additional specific contract QMP provisions 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 150 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 using a single mix design.
 - Less than 1000 cubic yards of non-slip-formed pavement placed using a single mix design.

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) If a comprehensive quality control plan is required under [701.1.2.2](#), submit a plan conforming to [701.1.2.2](#) and include additional concrete mix information as follows:
 1. Preliminary concrete mix information including proposed production facilities and sources of materials as well as the name, title, and phone number of the person developing the mix design.
 2. Proposed individual and combined aggregate gradation limits.
 3. Proposed methods for monitoring and recording batch weights.

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.
 - Submit previously-used department-approved mixes qualified based on field performance.
- (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) For lab-qualified or field-qualified mixes, in addition to the mix information required under [710.4](#), submit 2 copies of a concrete mix report at least 3 business days before producing concrete. For lab-qualified mixes, include strength data, test dates, and the name and location of the laboratory that performed mix development testing. For field-qualified mixes, include historical data that demonstrate acceptable strength and field performance.
- (4) Ensure that the concrete mix report includes a cover sheet with signature blocks for both the mix developer and the engineer. Have the mix developer sign and date each copy attesting that all information in the report is accurate. The engineer will sign and date each copy of the report. The engineer's signature verifies that the engineer had the opportunity to review the mix report, to check

that it meets the concrete mix requirements, and to comment. The engineer will return a signed copy to the contractor within 3 business days of receiving the report.

- (5) For new lab-qualified mixes, test the air void system of the proposed concrete mix. Include the SAM number as a part of the mix design submittal.

715.2.2 Combined Aggregate Gradation

- (1) Ensure that the combined aggregate gradation conforms to the following, expressed as weight percentages of the total aggregate:
 1. One hundred percent passes the 2-inch sieve.
 2. The percent passing the 1-inch sieve is less than or equal to 89. The engineer may waive this requirement if the clear spacing between reinforcing bars is less than 2 inches.
 3. The percent passing the No. 4 sieve is less than or equal to 42, except if the coarse aggregate is completely composed of crushed stone, up to 47 percent may pass the No. 4 sieve. For pavement, coarse aggregate may be completely composed of crushed concrete, in which case up to 47 percent may pass the No. 4 sieve.
 4. The percent passing the No. 200 sieve is less than or equal to 2.3 percent.
- (2) Submit proposed combined gradation limits and target individual gradations along with the mix information required under [710.4](#).

715.2.3 Class I Concrete Mixes

715.2.3.1 Require data from 5 trial batches for mix design acceptance.

715.2.3.1 Pavements and Cast-in-Place Barrier

- (1) Use at least 5 pairs of cylinders **from 5 separate trial batches** to demonstrate the compressive strength of a mix design. Use either laboratory strength data for new mixes or field strength data for established mixes. Demonstrate that the 28-day compressive 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](#).
- (2) Provide a minimum cement content of 565 pounds per cubic yard, except if using type I, IL, or III cement in a mix where the geologic composition of the coarse aggregate is primarily igneous or metamorphic materials, provide a minimum cement content of 660 pounds per cubic yard.
- (3) The contractor may use class C fly ash or grade 100 or 120 slag as a partial replacement for cement. For binary mixes use up to 30 percent fly ash or slag. For ternary mixes use up to 30 percent fly ash plus slag in combination. Replacement values are in percent by weight of the total cementitious material in the mix.
- (4) 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.
- (5) Do not use chloride based accelerators in mixes for new construction.

715.2.3.2 Structures

- (1) Qualify compressive strength according to ACI 301 - Specifications for Structural Concrete - subsections 4.2.3.1 through 4.2.3.4. Use either laboratory strength data for new mixes or field strength data for established mixes. 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 a mix grade containing fly ash (A-FA), slag (A-S), both fly ash and slag (A-T), or blended cement (A-IP, A-IL, A-IS, or A-IT) Ensure that the cementitious content equals or exceeds 565 pounds per cubic yard. Unless the engineer approves otherwise in writing, conform to one of the following:
 1. Use class C fly ash or grade 100 or 120 slag as a partial replacement for cement. For binary mixes use 15% to 30% fly ash or 20% to 30% slag. For ternary mixes use 15% to 30% fly ash plus slag in combination. Replacement values are in percent by weight of the total cementitious material in the mix.
 2. Use a type IP, IS, or IT blended cement.
- (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 [715.3.3.2](#).
- (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) Provide slump, air content, concrete temperature and compressive strength test results as specified in [710.5](#). Provide a battery of QC tests, consisting of results for each specified property, using a single sample randomly located within each subplot. If a subplot random test location falls within a mainline pavement gap, relocate the test to a different location within the subplot. Cast three cylinders for strength evaluation.
- (2) Test the air void system at least once per lot and enter the SAM number in the MRS for information only. SAM testing is not required for the following:
 - For lots with less than 4 sublots.
 - High early strength (HES) concrete.
 - Special high early strength (SHES) concrete.
 - Concrete placed under the following bid items:
 - Concrete Pavement Approach Slab
 - Concrete Masonry Culverts
 - Concrete Masonry Retaining Walls
 - Steel Grid Floor Concrete Filled
 - Crash Cushions Permanent
 - Crash Cushions Permanent Low Maintenance
 - Crash Cushions Temporary

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 within [715.3.1.2](#) as follows:

Mix design change A modification to the mix requiring the engineer's approval under [710.4\(5\)](#).

For paving and barrier mixes, a source change under item 1 of [710.4\(5\)](#) for fly ash of the same class that does not require a modification under items 2 through 4 of [710.4\(5\)](#) 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 Allow lane-feet sublots up to 25% longer than standard.
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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 subplot 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 subplot. For partial sublots exceeding 25 percent of the standard length, notify the engineer who will direct additional testing to represent that partial subplot.**
 - Ensure that subplot limits match for adjacent paving passes. Pavement gaps do not affect the location of subplot limits.
 - Create lots by grouping 4 to 8 adjacent sublots matching lots created for adjacent paving passes.
- (2) If a subplot random test location falls in a pavement gap, test at a different random location within that subplot.

715.3.1.2.3 Allow CY sublots up to 25% larger than the standard.

715.3.1.2.3 Lots by Cubic Yard

- (1) Define standard lots and sublots conforming to the following:
 - Do not designate more than one subplot per truckload of concrete. **The contractor may include sublots less than or equal to 25 percent of the standard volume in the previous subplot. For partial sublots exceeding 25**

percent of the standard volume, notify the engineer who will direct additional testing to represent that partial subplot.

- Lots for structures are a maximum of 500 cubic yards divided into approximately equal 50-cubic-yard or smaller sublots.
- Lots for barrier are a maximum of 1000 cubic yards divided into approximately equal 100-cubic-yard or smaller sublots.
- Lots for pavement are a maximum of 2000 cubic yards divided into approximately equal 250-cubic-yard or smaller sublots.

- (2) The contractor may designate lots smaller than standard sized. An undersized lot is eligible for incentive payment under [715.5](#) if the contractor defines 4 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 compressive 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 compressive strength on a lot-by-lot basis using the compressive strength of contractor QC cylinders. The department will assess concrete for removal and replacement based on a subplot-by-subplot analysis of core strength. Perform coring and testing, fill core holes with an engineer-approved non-shrink grout, and provide traffic control during coring.
- (2) Randomly select 2 QC cylinders to test at 28 days for percent within limits (PWL). Compare the strengths of the 2 randomly selected QC cylinders and determine the 28-day subplot average strength as follows:
- If the lower strength divided by the higher strength is 0.9 or more, average the 2 QC cylinders.
 - If the lower strength divided by the higher strength is less than 0.9, break one additional cylinder and average the 2 higher strength cylinders.

715.3.2.2 Removal and Replacement

715.3.2.2.1 Pavement

- (1) If a subplot strength is less than 2500 psi, the department may direct the contractor to core that subplot to determine its structural adequacy and whether to direct removal. Cut and test cores according to AASHTO T24 as and where the engineer directs. Have an HTCP-certified PCC technician I perform or observe the coring.
- (2) The subplot pavement is conforming if the compressive strengths of all cores from the subplot are 2500 psi or greater or the engineer does not require coring.
- (3) The subplot pavement is nonconforming if the compressive strengths of any core from the subplot is less than 2500 psi. The department may direct removal and replacement or otherwise determine the final disposition of nonconforming material as specified in [106.5](#).

715.3.2.2.2 Structures and Cast-in-Place Barrier

- (1) The department will evaluate the subplot for possible removal and replacement if the 28-day subplot average strength is lower than $f'c$ minus 500 psi. The value of $f'c$ is the design stress the plans show. The department may assess further strength price reductions or require removal and replacement only after coring the subplot.
- (2) The engineer may initially evaluate the subplot strength using a non-destructive method. Based on the results of non-destructive testing, the department may accept the subplot at the previously determined pay for the lot, or direct the contractor to core the subplot.
- (3) If the engineer directs coring, obtain three cores from the subplot in question. Have an HTCP-certified PCC technician I perform or observe core sampling according to AASHTO T24. Determine core locations, subject to the engineer's approval, that do not interfere with structural steel.
- (4) Have an independent consultant test cores according to AASHTO T24.
- (5) 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 engineer will accept the subplot at the previously determined pay for the lot. If the 3-core average is less than 85 percent of $f'c$, or an individual core is less than 75 percent of $f'c$, the

engineer may require the contractor to remove and replace the subplot or assess a price reduction of \$35 per cubic yard or more.

715.3.3 Aggregate

715.3.3.1 General

- (1) Except as allowed for small quantities in [710.2](#), provide aggregate test results 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 used to test the percent passing the No. 200 sieve.
- (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 compressive strength under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
715.0415	Incentive Strength Concrete Pavement	DOL
715.0502	Incentive Strength Concrete Structures	DOL
715.0603	Incentive Strength Concrete Barrier	DOL

- (2) Incentive payment may be more or less than the amount the schedule of items shows.
- (3) The department will administer disincentives for compressive strength under the Disincentive Strength Concrete Pavement, Disincentive Strength Concrete Structures, and Disincentive Strength Concrete Barrier administrative items.
- (4) The department will adjust pay for each lot using PWL of the 28-day subplot average strengths for that lot. The department will measure PWL relative to the lower specification limit of 3700 psi for pavements and 4000 psi for structures and barrier. 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 [715.3.1.2.1](#).
- (5) Submit strength results to the department electronically using the MRS software. The department will validate contractor data before determining pay adjustments.
- (6) 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

- (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.
- (3) For lots with a full battery of QC tests at less than 4 locations, there is no incentive but the department will assess a disincentive based on the individual subplot 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 tests 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 a 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	$(7/8 \times \text{PWL}) - 78.75$
< 50	-35

- (2) The department will not pay incentive if the lot standard deviation is greater than 350 psi.
- (3) For lots with less than 4 sublots, there is no incentive but the department will assess a disincentive based on the individual subplot average strengths. The department will reduce pay for sublots with an average strength below 4000 psi by \$35 per cubic yard.