



**DEVELOPMENTAL SPECIFICATIONS  
FOR  
QUALITY MANAGEMENT CONCRETE (QM-C)**

Effective Date  
October 17, 2023

**THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**23027.01 DESCRIPTION.**

- A. This specification identifies a concrete mixture design with an optimum combined aggregate gradation, and the Contractor’s testing and quality control responsibilities. Optimization of the aggregates should produce concrete with low water requirement as well as improved workability and finishing characteristics. While concrete strength is important and is measured, it is not the basis for optimization of the concrete mixture design.
- B. Testing and quality control apply to all Contractor produced concrete using the Concrete Design Mixture (CDM). The CDM applies to mainline slip form pavement. At the Contractor’s option, the CDM may apply to any other slip form paving.

**23027.02 MATERIALS.**

For all materials, meet the quality requirements for the respective items in Division 41 of the Standard Specifications. Compatibility of all material combinations is the Contractor’s responsibility based on acquired field experience with proposed materials.

**23027.03 CONCRETE DESIGN MIXTURE.**

- A. An Iowa DOT PCC Level III Certified Technician is responsible for the development of the CDM. Develop a CDM based on a unit volume of 1.000 according to industry standard practice, and containing proportions of materials, including admixtures. Base the proportions upon saturated surface dry aggregates to produce a workable concrete mixture meeting the constraints of Table DS-23027.03-1:

**Table DS-23027.03-1: Concrete Mixture Constraints**

Nominal Maximum Coarse Aggregate Size	Greater than or equal to 1 inch
Gradation	<a href="#">Materials I.M. 532</a>
Cementitious Content	Minimum, 560 pounds per cubic yard*
Fly Ash Substitution Rate	See <a href="#">Article 2301.02, B, 6</a>
Water/Cementitious Ratio	Maximum, 0.42
Air Content	6% ± 1%, Design Absolute Volume = 0.060
28 Day Flexural Strength, Third Point	Minimum, 640 pounds per square inch

\* The minimum cement content assumes the use of Type I/II cement with a specific gravity of 3.14 for an absolute volume of 0.106. If cement other than Type I/II is used, use an absolute volume of 0.106 and determine the weight of cement from the specific gravity of the cement. Cement content may need to be increased to maintain the water to cementitious ratio during hot weather conditions.

- B. Develop a target combined gradation in Zone II for each CDM based on normal production gradations and the relative percentages of each individual aggregate. Submit Form 955QMC to aggregate producer(s) to ensure individual gradations used are acceptable. Limit the percent passing the No. 200 sieve to no more than 1.5% for the combined aggregate gradation. When the coarse aggregate used meets the increase in percent passing the No. 200 sieve, according to [Section 4109](#), Aggregate Gradation Table, Note 10 of the Standard Specifications, limit the percent passing the No. 200 sieve to no more than 2.0% for the combined aggregate gradation.
- C. Contractor may use water reducing admixture, Type A, or water reducing and retarding admixture, Type D, in the CDM.

**23027.04 MIX DESIGN DOCUMENTATION.**

At least 7 calendar days prior to the start of paving, submit a CDM report to the District Materials Engineer for approval on Iowa DOT form. Contract extensions will not be allowed due to inadequate or additional CDMs.

**23027.05 QUALITY CONTROL.**

**A. General.**

- 1. The Contractor is responsible for quality control of the concrete. An Iowa DOT PCC Level II Certified Technician is required to oversee quality control operations. The individual conducting the testing on grade is required to be an Iowa DOT PCC Level I Certified Technician. Calibrate and correlate testing equipment prior to and during paving operations.
- 2. At least 7 calendar days prior to the preconstruction conference, submit to the Engineer a Quality Control Plan complying with [Materials I.M. 530](#). Include the proposed mix design(s) with the Quality Control Plan. Do not begin paving until the plan is reviewed for compliance with the contract documents. Maintain equipment and qualified personnel to direct and perform all field quality control sampling and testing necessary to:
  - Determine the various properties of the concrete governed by the contract documents, and
  - Maintain the properties described in this specification.

**B. Quality Control Testing.**

- 1. Perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Plan. Take samples for quality control testing in a random manner according to the prescribed sampling rate. Perform the tests listed in Table DS-23027.05-1:

**Table DS-23027.05-1: Quality Control Table**

	Limits	Testing Frequency	Test Methods
Unit Weight (Mass) of Plastic Concrete	Monitor for changes, ± 3%	Twice/day	AASHTO T 121
Gradation Combined % Passing	See Paragraph 2 below	1/1500 cubic yard	<a href="#">Materials I.M. 216, 301, 302, 531</a>
Aggregate Moisture Contents	See <a href="#">Materials I.M. 527</a>	1/1500 cubic yard	<a href="#">Materials I.M. 308</a>
Air Content Plastic Concrete In Front of Paver	See <a href="#">Article 2301.02, B, 4</a>	1/350 cubic yard 1/100 cubic yard (ready mix)	<a href="#">Materials I.M. 318</a>

Air Content Plastic Concrete In Back of Paver	May be used by Project Engineer to adjust target air in front of paver	2/day for first 3 days and 1/week thereafter (for each paver used)	<a href="#">Materials I.M. 318</a>
Water/Cementitious Ratio	0.42 maximum	Twice/day	<a href="#">Materials I.M. 527</a>
Vibrator Frequency	See Article <a href="#">2301.03, A. 3, a, 6. a</a>	With Electronic Vibration Monitoring: Twice/day Without Electronic Vibration Monitoring: Twice/Vibrator/Day	<a href="#">Materials I.M. 384</a>

- Maintain the running average of three combined aggregate gradation tests within the limits established by the CDM target gradation and the working ranges of Table DS-23027.05-2:

Table DS-23027.05-2: CDM Target Gradations

Sieve Size	Working Range
No. 4 or greater	± 5%
No. 8 to No. 30	± 4%
No. 50	± 3%
No. 100	± 2%
minus No. 200	See Article DS-23027.03

### C. Corrective Action.

For QM-C mixes only, plot all process control test results on control charts as described in [Materials I.M. 530](#).

#### 1. Aggregate Tests.

Take corrective action when the running average approaches the working range limits. When a combined gradation test result for a sieve exceeds the working range limits, adjust the target and notify the Engineer. If the verification test result for the minus No. 200 exceeds the limits in Article DS-23027.03 for the combined gradation, the material represented by that test for this sieve will be considered non-complying. Price adjustments will be assessed based on Coarseness/Workability Factors as described in Article DS-23027.07, E.

#### 2. Concrete Tests.

Take corrective action when an individual test result approaches the control limits. Notify the Engineer whenever an individual test result exceeds the control limits.

### D. Acceptable Field Adjustments.

- All mix changes must be mutually agreed upon between the Contractor and Engineer. Document all mix changes on the QM-C Mix Adjustment form. Determine batch weights using a basic water cement ratio of 0.40. When the water cement ratio varies more than  $\pm 0.03$  from the basic water cement ratio, adjust the mix design to unit volume of 1.000. A change in the source of materials or an addition of admixtures or additives requires a new CDM. The following are small adjustments that may be made without a new CDM being required:
  - Increase cementitious content.
  - Decrease fly ash substitution rate.
  - Aggregate proportions may be adjusted from CDM proportions by a maximum of  $\pm 4\%$  for each aggregate.
  - Change water reducer to water reducer retarder.
  - Adjustment in water reducer or water reducer retarder admixture dosage.
  - Change in source of fly ash.
  - Change in source of sand, provided target gradation limits are met.

2. When circumstances arise, such as a cement plant breakdown, that create cement supply problems, a change in cement source may be allowed with the Engineer's approval. Consult the District Materials Engineer for approval of other changes to the mix design. A set of three beams for 28 day flexural strength testing may be required to document the changes.
3. Should conditions beyond the Contractor's control prevent completion of the work with the CDM, a Class C mix, or a mix based on Class C mix proportions using project materials, will be allowed, at no additional cost to the Contracting Authority. Mutual agreement between the Contractor and Engineer is required. When Class C mix, or mix based on Class C mix proportions using project materials is allowed it will not be considered in the coarseness and workability lot evaluation.

**E. Hand Finished Pavement.**

Use project materials based on Class C or Class M concrete mix proportions. With approval of the Engineer, the Contractor's CDM may be used for hand finished pavement. Quality control, as required in this specification, will not apply to hand finished pavement.

**23027.06 METHOD OF MEASUREMENT.**

Measurement will be as follows:

- A. Standard or Slip-Form Portland Cement Concrete Pavement, QM-C.**  
Square yards shown in the contract documents.
- B. Portland Cement Concrete Overlay, QM-C, Furnish Only.**  
[Article 2310.04, A](#), of the Standard Specifications applies.
- C. Portland Cement Concrete Overlay, QM-C, Placement Only.**  
[Article 2310.04, B](#), of the Standard Specifications applies.
- D. Hand Finished Pavement.**  
Square yards of Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, constructed using Class C or Class M mixtures. For overlays, the Engineer will compute the number of:
  - Square yards of Portland Cement Concrete Overlay, QM-C, Placement Only, constructed using Class C or Class M mixtures, and
  - Cubic yards of Class C and Class M mixtures used.

**23027.07 BASIS OF PAYMENT.**

The cost for furnishing labor, equipment, and materials for the work required by the Contractor to design, test, and provide process control for production of QM-C shall be included in the contract unit price for QM-C bid items. Payment will be the contract unit prices as follows:

- A. Standard or Slip Form Portland Cement Concrete Pavement, QM-C.**  
Contract unit price for Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, per square yard.
- B. Portland Cement Concrete Overlay, QM-C, Furnish Only.**  
[Article 2310.05, A](#), of the Standard Specifications applies. Average coarseness and workability factor for each lot will be determined according to [Materials I.M. 530](#).
- C. Portland Cement Concrete Overlay, QM-C, Placement Only.**  
[Article 2310.05, B](#), of the Standard Specifications applies. Average coarseness and workability factor for each lot will be determined according to [Materials I.M. 530](#).
- D. Hand Finished Pavement.**
  1. Standard or Slip-Form Portland Cement Concrete Pavement, QM-C: per square yard.

- 2. Portland Cement Concrete Overlay, QM-C, Placement Only: per square yard.
- 3. Portland Cement Concrete Overlay, QM-C, Furnish Only: per cubic yard.

**E. Price Adjustment**

Failure to provide an optimized gradation within Zone II, when required, will result in the following price adjustments.

**Table DS-23027.07-1: Price Adjustments**

<b>Gradation Zone (Materials I.M. 532)</b>	<b>Price Adjustment Per Lot</b>
IV	2%
I	5%