



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

**Effective Date  
July 15, 2008**

**THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**01115.01 DESCRIPTION.**

This ~~Supplemental~~ 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 with improved workability and finishing characteristics. While concrete strength is important and shall be measured, it is not the basis for optimization of the concrete mixture design.

Testing and quality control shall apply to all Contractor produced concrete, utilizing the Concrete Design Mixture (CDM). The CDM shall apply to mainline slip form pavement. At the Contractor's option, the CDM may apply to any other slip form paving.

**01115.02 MATERIALS.**

All materials shall meet the quality requirements for the respective items in Division 41 of the Standard Specifications. Compatibility of all material combinations shall be the responsibility of the Contractor based on acquired field experience with proposed materials.

**A. Coarse and Fine Aggregate.**

The Gradation Table in Article 4109.02 of the Standard Specifications will not apply to coarse aggregate. Fine aggregate sources shall meet the requirements of Section 4110 of the Standard Specifications. A coarse, uncrushed sand may be produced from an approved Class 2, Class 3, or Class 3I gravel source meeting the requirements of Section 4110 of the Standard Specifications and the following gradation limits:

**Table 01115.02, A**

<b>Sieve</b>	<b>% Passing</b>
1/2 inch (12.5 mm)	100
3/8 inch (9.5 mm)	90-100
No. 4 (4.75 mm)	75-95
No. 8 (2.36 mm)	60-90
No. 30 (600 µm)	10-60
No. 200 (75 µm)	0-1.5

**B. Intermediate Aggregate.**

Any limestone intermediate aggregate material shall be produced from approved beds and meet the durability class required for the coarse aggregate. Intermediate aggregate shall be considered coarse aggregate for gradations and correlations.

Uncrushed pea gravel produced from an approved Class 2 or Class 3 gravel source and meeting the quality requirements of Section 4110 of the Standard Specifications shall not exceed 10% of the total aggregate for a Class 2 gravel source, or 15% of the total aggregate for a Class 3 gravel source.

**01115.03 LABORATORY DESIGN MIXTURE.**

The Contractor shall develop a CDM based on a unit volume of 1.000 according to industry standard practice. The CDM shall contain proportions of materials, including admixtures. Proportions shall be based upon saturated surface dry aggregates and shall produce a workable concrete mixture meeting the following constraints:

**Table 01115.03-1**

Nominal Maximum Coarse Aggregate Size	Greater than or equal to 1 inch (25 mm)
Gradation	Materials I.M. 532
Cementitious Content	Minimum, 560 lbs./cy* (333 kg/m <sup>3</sup> *)
Fly Ash Substitution Rate	See Article 2301.04 Paragraph E
Water/Cementitious Ratio	Maximum, 0.45
Air Content	6% ± 1%, Design Absolute Volume = 0.060
28 Day Flexural Strength, Third Point	Minimum, 640 psi (4.40 MPa)

\*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. The absolute volume shall be 0.106 and the weight (mass) of cement shall be determined from the specific gravity of the cement, if other than Type I/II cement. The absolute volume of cement for Type IP cement shall be 0.111. Cement content may need to be increased to maintain water to cementitious ratio during hot weather conditions.

Normal production gradations shall be used to determine the relative percentage of each individual aggregate used in the CDM. The relative percentage of each individual aggregate shall be selected to produce the desired combined aggregate gradation using the following sieves: 2 inch, 1 1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200 (50 mm, 37.5 mm, 25 mm, 19 mm, 12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 300 µm, 150 µm, and 75 µm). A target combined gradation shall be developed for each CDM based on normal production gradations and the relative percentages of each individual aggregate. Percent passing the No. 200 (75 µm) sieve shall not exceed 1.5% for the combined aggregate gradation. When the coarse aggregate used meets the increase in percent passing the No. 200 (75 µm) sieve, in accordance with Article 4115.05 of the Standard Specifications, the percent passing the No. 200 (75 µm) sieve shall not exceed 2.0% for the combined aggregate gradation. Water reducing admixture, Type A, or water reducing and retarding admixture, Type D, may be used in the CDM.

Laboratory development of the CDM shall be in accordance with AASHTO T 126. Mix designs may be conducted in a ready mix or central mix batch plant provided the following conditions are met:

1. All non-mix design materials are emptied.
2. Mix design materials are used.
3. Batch size at least 3 cubic yards (2 m<sup>3</sup>).

Personnel overseeing the development of the CDM shall be an Iowa DOT PCC Level III Certified Technician. The Engineer shall be allowed to witness the development of the CDM. Notice shall be given 7 calendar days prior to this event. The following tests shall be performed in the development of the CDM:

**Table 01115.03-2**

Specific Gravity of Each Individual Aggregate	Materials I.M. 307
Gradation of Each Individual Aggregate	Materials I.M. 302
Unit Weight of Plastic Concrete	AASHTO T 121
Air Content of Plastic Concrete	Materials I.M. 318
28 Day Flexural Strength	AASHTO T 97
Temperature of Plastic Concrete	ASTM C 1064

**01115.04 MIX DESIGN DOCUMENTATION.**

At least 7 calendar days prior to the start of paving the Contractor shall submit a CDM report to the District Materials Engineer for approval. Contract extensions will not be allowed due to inadequate or additional CDMs. The CDM report shall include the following:

<b>Table 01115.04</b>	
Cover Page	Contractor name Project number Date and location of CDM laboratory development Date Submitted Signature of Contractor representative
Material Source Information	Brand Type Source
Material Proportion Information	Specific gravity Relative percentage of each individual aggregate Target combined gradation % passing (Materials I.M. 531) Target combined gradation charts (Materials I.M. 532) Design batch weight (mass) (SSD) As mixed batch weight (mass) (SSD)
Mix Properties	Unit weight (mass) of plastic concrete Air content of plastic concrete 28 day flexural strength Slump Temperature of plastic concrete

The District Materials Engineer may approve the mix design without laboratory mixture testing if the proposed mix design proportions fall within Zone II-A of Materials I.M. 532. If the mix design is approved without laboratory testing, the Contractor shall cast a set of three beams on the first day of paving from concrete meeting the mix design criteria. The Contractor shall test the beams for 28 day flexural strength, third point loading. When the coarse aggregate for the mix design is quartzite, an additional set of three beams shall be cast and tested by the Contractor at 90 days. The strength results shall be submitted to the Engineer.

**01115.05 QUALITY CONTROL.**

Quality control of the concrete shall be the responsibility of the Contractor. Personnel overseeing quality control operations shall be an Iowa DOT PCC Level II Certified Technician. Personnel conducting testing on grade shall be an Iowa DOT PCC Level I Certified Technician or Concrete Field Testing Technician Grade I in accordance with ACI CP-2. The Contractor shall calibrate and correlate testing equipment prior to and during paving operations. The Quality Control Plan and Project Information Quality Control Plan, in accordance with Materials I.M. 530, shall be submitted to the Engineer at least 7 calendar days prior to the preconstruction conference. Paving shall not begin until the plan is reviewed for conformance with the contract documents. The Contractor shall maintain equipment and qualified personnel who shall 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 to maintain the properties described in this Supplemental Specification.

**A. Quality Control Testing.**

The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this Supplemental Specification and as set forth in the Quality

Control Plan. All samples for quality control testing shall be taken in a random manner according to the prescribed sampling rate. The Contractor shall perform the following tests described herein:

**Table 01115.05, A-1  
QUALITY CONTROL TABLE**

	Limits	Minimum Testing Frequency	Test Methods
Unit Weight (Mass) of Plastic Concrete	±3% of the CDM	Twice/day	AASHTO T 121
Gradation Combined % Passing	See below	1/1500 cy (1/1200 m <sup>3</sup> )	Materials I.M. 216, 301, 302, & 531
Aggregate Moisture Contents	See Materials I.M. 527	1/1500 cy (1/1200 m <sup>3</sup> )	Materials I.M. 308
Air Content Plastic Concrete In Front of Paver	See Article 2301.04, C	1/350 cy (1/275 m <sup>3</sup> ) See below	Materials I.M. 318
Water/Cementitious Ratio	0.45 maximum	Twice/day	Materials I.M. 527
Vibrator Frequency	See Article 2301.07,A,6,a	With Electronic Vibration Monitoring: Twice/day  Without Electronic Vibration Monitoring: Twice/Vibrator/Day	Materials I.M. 384

Gradation shall be performed at a frequency listed in the table above. The running average of three combined aggregate gradation tests shall fall within the limits established by the CDM target gradation and the following working ranges:

Table 01115.05, A-2	
Sieve Size	Working Range
No. 4 or greater (4.75 mm or greater)	± 5%
No. 8 to No. 30 (2.36 mm to 600 µm)	± 4%
No. 50 (300 µm)	± 3%
No. 100 (150 µm)	± 2%
minus No. 200 (75 µm)	See Article 01115.03

**B. Corrective Action.**

For QM-C mixes only, the Contractor shall plot all quality control test results on control charts as described in Materials I.M. 530.

**1. Aggregate Tests.**

When the running average approaches the working range limits, the Contractor shall take corrective action. When a combined gradation test result for a sieve exceeds the working range limits, the target shall be adjusted and the Engineer shall be notified. If the verification test result for the minus No. 200 (75 µm) exceeds the limits in Article 01115.03 of this specification for the combined gradation, the material represented by that test for this sieve will be considered non-complying. Pay factors will be assessed based on Coarseness/Workability Factors as described in Article 01115.07 of this ~~Supplemental S~~ Specification.

**2. Concrete Tests.**

When an individual test result approaches the control limits, the Contractor shall take corrective action. The Contractor shall notify the Engineer whenever an individual test result exceeds the control limits.

**C. Acceptable Field Adjustments.**

All mix changes shall be documented by the Contractor on the QM-C Mix Adjustment form and mutually agreed upon between the Contractor and Engineer. Batch weights shall be determined using a basic water cement ratio of 0.40. When the water cement ratio varies more than ±0.03 from the basic water cement ratio, the mix design shall be adjusted to a unit volume of 1.000. A change in the source of materials or an addition of admixtures or additives shall necessitate 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  $\pm 2\%$  for the coarse aggregate and  $\pm 2\%$  for the fine aggregate. The coarse and intermediate aggregates may be adjusted from CDM proportions by a maximum of  $\pm 5\%$  in the coarse fraction.
- 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

When circumstances arise, such as a cement plant breakdown, that create cement supply problems, a change in cement source may be allowed with approval of the Engineer. The District Materials Engineer shall be consulted 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. The Contractor will be allowed to utilize a Class C mix or a mix based on Class C mix proportions utilizing project materials in the event conditions beyond the Contractor's control prevent completion of the work with the CDM. This shall be by mutual agreement between the Contractor and Engineer and at no additional cost to the Contracting Authority.

Prior to 28 days strength test results, paving with QM-C mix may begin when the mix design strength, based on the average of three beams, meets or exceeds 640 psi (4.4 MPa) with the approval of the Engineer.

**D. Hand Finished Pavement.**

Contractor produced concrete for hand finished pavement shall utilize 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 specified in this Supplemental Specification, shall not apply to hand finished concrete.~~ Hand finished pavement may utilize Class C or M ready mix concrete without the requirements of this ~~Supplemental Specification.~~

**01115.06 METHOD OF MEASUREMENT.**

**A. Quality Management Concrete (QM-C).**

The Engineer will compute the number of cubic yards (cubic meters) of QM-C based on the number of batches produced upon which quality control and testing were performed. This QM-C quantity will also include the quantity of QM-C produced at the Contractor's option as referenced in Article 01115.01 of this ~~Supplemental Specification~~ and Class C mixture used in accordance with Article 01115.05, C, of this ~~Supplemental Specification~~. All quantity of waste will be excluded from this quantity.

**B. Standard or Slip-Form Portland Cement Concrete Pavement, QM-C.**

The quantity of Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, in square yards (square meters), will be the quantity shown in the contract documents.

**C. Portland Cement Concrete Overlay, QM-C, Furnish Only.**

Article 2310.04, A, of the Standard Specifications will apply.

**D. Portland Cement Concrete Overlay, QM-C, Placement Only.**

Article 2310.04, B, of the Standard Specifications will apply.

**E. Class C and Class M Mixtures.**

The Engineer will compute the number of square yards (square meters) of Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, constructed utilizing Class C or Class M mixtures. For overlays, the Engineer will compute the number of square yards (square meters) of Portland Cement Concrete Overlay, QM-C, Placement Only, constructed utilizing Class C or Class M mixtures and the number of cubic yards (cubic meters) of Class C and Class M mixtures used.

**01115.07 BASIS OF PAYMENT.**

For construction of concrete pavement and other construction in connection therewith, the Contractor will be paid the contract unit prices for the following items of work:

**A. Quality Management Concrete (QM-C).**

For the number of cubic yards (cubic meters) of QM-C computed as provided above, the Contractor will be paid the predetermined contract unit price for Quality Management-Concrete per cubic yard (cubic meter). This price will be considered full compensation for furnishing all labor, equipment, and materials for the work required by the Contractor to design, test, and provide process control for the production of QM-C.

**B. Standard or Slip Form Portland Cement Concrete Pavement, QM-C.**

For the number of square yards (square meters) of Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, constructed, the Engineer will determine the average coarseness and workability factors for each lot in accordance with Materials I.M. 530.

The contract unit price per square yard (square meter) for Standard or Slip-Form Portland Cement Concrete Pavement, QM-C, constructed will be adjusted in the following manner:

<b>Table 01115.07, B Pay Factor Chart</b>	
<b>Gradation Zone (Materials I.M. 532)</b>	<b>Pay Factor</b>
II-A	1.03
II-B	1.02
II-C	1.01
II-D	1.00
IV	0.98
I	0.95

**C. Portland Cement Concrete Overlay, QM-C, Furnish Only**

Article 2310.04, A, of the Standard Specifications will apply. The Engineer will determine the average coarseness and workability factor for each lot according to Materials I.M. 530. The contract unit price will be adjusted according to Table 01115.07 B, of this specification.

**D. Portland Cement Concrete Overlay, QM-C, Placement Only**

Article 2310.04, B, of the Standard Specifications will apply. The Engineer will determine the average coarseness and workability factor for each lot according to Materials I.M. 530. The contract unit price will be adjusted according to Table 01115.07, B, of this specification.

**E. Class C and Class M Mixtures.**

For the number of square yards (square meters) of Class C and Class M mixtures constructed, the Contractor will be paid the contract unit price per square yard (square meter) for Standard or Slip-Form Portland Cement Concrete Pavement, QM-C. For overlays, the Contractor will be paid the contract unit price per square yard (square meter) for Portland Cement Concrete Overlay, QM-C, Placement Only, and the contract unit price per cubic yard (cubic meter) for Portland Cement

Concrete Overlay, QM-C, Furnish Only. Pay Factor incentives/disincentives in Article 01115.07, B, of this specification, will not be applied to Class C and Class M mixtures.