ROAD COMMISSION FOR OAKLAND COUNTY

SPECIAL PROVISION
FOR
**QUALITY CONTROL AND ACCEPTANCE OF PORTLAND CEMENT CONCRETE**


ORG:03-26-21
FHWA:05-25-21

## a. Description

This special provision establishes Portland Cement Concrete (PCC) Quality Control (QC) and Quality Assurance (QA) and shall be completed in accordance with the *Michigan Department of Transportation (MDOT) 2020 Standard Specifications for Construction, S*ections 1002, 1003 and 1004 and as modified herein. The Contractor will be responsible for all QC testing and RCOC will be responsible for all QA testing. The PCC mixture shall be provided to meet the requirements of Section 1004 of the *MDOT 2020 Standard Specifications for Construction* except where modified herein.

## b. Terminology

1. Air Content of Fresh Concrete.
The recorded total air content of fresh concrete sampled and tested according to the *MDOT 2020 Standard Specifications for Construction* and as modified herein.

2. Concrete Mix Design.
The process by which the concrete mixture performance characteristics are defined based on selected materials, performance requirements, environmental exposure considerations, placement methods and other factors that control the plastic and hardened properties of the concrete in efforts to produce an economical and durable product.

3. Job Mix Formula (JMF).
The actual batch quantities (mixture proportions) of each constituent included in the concrete mixture, based on adjustments to the target weights from the mix design, necessary to optimize the concrete mixture properties. Submit mix design and JMF on the MDOT Job Mix Formula Concrete Field Communication form or similar form and include all accompanying documentation.

4. Quality Control (QC).
All activities administered by the Contractor to monitor, assess and adjust production and placement processes to ensure the final product will meet the specified levels of quality, including, but not limited to, training, materials sampling, testing, project oversight and documentation.

5. Quality Assurance (QA).
Activities administered by the Road Commission for Oakland County (RCOC) dealing with acceptance of the product, including, but not limited to, materials sampling, testing, construction inspection, and review of Contractor QC documentation. All concrete QA sampling and testing will be performed by the Engineer.

6. QC Action Limits.
A range of values established by the Contractor and approved by the Engineer in the QC plan that, if exceeded, requires corrective action be taken by the Contractor to restore the continuity and uniformity of the mixture and methods in conformance with specification requirements. The QC action limits must not exceed the QC suspension limits.

7. QC Plan.
The project-specific plan developed by the Contractor describing, in detail, all aspects of production and construction for the project to ensure consistent control of quality to meet specification requirements.

8. QC Plan Administrator.
An employee of or consultant engaged by the Contractor, responsible for developing and overseeing all aspects of QC for the project. The duties of this individual include, but are not limited to, preparing the QC plan, managing the Contractor QC personnel, communicating routinely with the production personnel to ensure quality, initiating corrective action and suspending operations when the process is found to be producing non-conforming materials, and preparing and submitting all necessary QC documentation to the Engineer within the specified time period.

9. QC Suspension Limits.
The Minimum or Maximum values per the specifications for Total Air Content of Fresh Concrete, Concrete Temperature, and Slump of Concrete which, if exceeded on a single QC test, requires that the Contractor suspend operations and determine, correct, and document the deficiencies before resuming production. The Engineer must approve all changes prior to resuming production. The QC suspension limits must not exceed specification requirement thresholds.

10. Strength Test Results.
An initial strength test result consists of the average 28-day compressive strength of two companion 6-inch by 12-inch or 4-inch by 8-inch cylinders taken from the same sample of concrete is considered a strength sample test result. 4-inch by 8-inch cylinders are only permitted if the nominal maximum coarse aggregate particle size, as specified for coarse aggregate in mixture, is 1-inch or less. If either non-destructive testing or coring is required, a test result is one reading taken with an approved non-destructive test instrument of compressive strength or one concrete core.

11. Supplementary Cementitious Materials.
A mineral admixture (slag cement, fly ash) used to replace a portion of the Portland cement, either individually, or as a blended cement in the concrete mixture.

12. Small Incidental Quantity.
A single day’s placement of 20 cubic yards or less of concrete used for non-structural

or non-pavement related applications, including but not limited to curb and gutter, sidewalks and sidewalk ramps (excluding driveways and driveway ramps), installing sign or fence posts, guard rail or cable rail foundations (excluding end anchorage foundations), or other contract items where the small quantity of concrete is not paid for separately as approved by the Engineer.

**c. Contractor Administered Quality Control Plan**

The Contractor shall prepare and implement a QC Plan in accordance with the *MDOT 2020 Standard Specifications for Construction* and as modified below.

All concrete placed is required to be tested for Quality Control.

Develop concrete mix designs and JMF(s) as specified and conduct QC sampling, testing, and inspection during all phases of the concrete work at the minimum frequency, or at an increased frequency sufficient to ensure that the work conforms to specification requirements.

Submit the QC Plan, for the appropriate items of work, to the Engineer for review a minimum of 10 working days before the start of related work. Do not begin concrete placement before approval or acceptance of the QC Plan by the Engineer. The Engineer will notify the Contractor of any objections relative to the content of the QC Plan within 5 working days of receipt of the QC Plan. Working days include Monday through Friday and exclude Saturday, Sunday, and Holidays. If the approved QC Plan fails to provide acceptable work, or acceptable control of the work, the Engineer may require the Contractor to revise the QC Plan. Revisions to the QC Plan must be approved by the Engineer prior to resuming work.

The Engineer will withhold acceptance of the concrete for failure to provide properly documented and timely QC records and reports.

**d. Concrete Mix Design and Documentation**

All concrete mix designs and JMF's will be Contractor provided.

All Concrete Grades will require 25 to 40 percent replacement of Portland cement in the concrete mixture with slag cement (Grade 100 minimum) and or fly ash.

Design strength, 28-day compressive strength, compressive design strength of concrete mixture and/or required design strength, shall meet the requirements of section 1004- as specified in the *MDOT 2020 Standard Specifications for Construction*.

**e. Quality Control Sampling and Testing**

The following are the minimum concrete quality control sampling and testing requirements.

When directed by the Engineer, sample and test all material that appears inconsistent

with similar material being sampled, unless the material is removed and replaced or corrected.

1. **Concrete Yield Determination**

After the start of the first concreting operation for each mix design and immediately after the specified slump and total air content have been attained, determine density (unit weight). The average of the density (unit weight) from three different batches will be the density (unit weight) of the concrete. Determine the actual yield using this density (unit weight) and adjust the mix design to correct the actual yield to correspond to the theoretical yield. The Engineer shall be notified and approve any adjustment to be made to the mix design.

As work progresses, verify the actual yield. If the yield based on a single density (unit weight) determination differs from the theoretical yield (adjusted for differences in air content) more than plus or minus 2 percent of the mix design (JMF) theoretical yield, make two additional density (unit weights) determinations. Use the average of the three determinations as the density of the concrete. Determine the yield from the average unit weight, and again adjust the mix design to correct the actual yield to correspond to the theoretical yield.

2. **Concrete Temperature, Slump and Total Air Content Determination**

Conduct sampling and testing for temperature, slump, and total air content on the first load, and on subsequent loads if directed by the Engineer, for each grade of concrete delivered to the work site each day. Do not begin concrete placement until quality control tests verity that the concrete meets specifications.

During concrete placement, test for temperature, slump, and air content of the concrete at a minimum of once per hour.

No concrete that is found to be out of specification for temperature, slump, or air content shall be placed. Quality control personnel shall stop the concrete placement and if possible, correct the deficiency. If the deficiency cannot be corrected, the load shall be rejected, and the next load(s) shall be tested. The RCOC reserves the right to halt concrete production if the quality control personnel are not present, do not have the appropriate equipment at the start of the first concreting operation for each mix design, or are not performing QC tests in accordance with the QC plan at the required frequency and in accordance with the prescribed test methods.

3. **Concrete Strength Determination**

Determine the 28-day concrete compressive strength on samples taken at least once every 200 cubic yards of a specific mix design, except that no less than one or more than four samples, evenly spread throughout day, need to be taken for one day's production of the mix. To determine the size of cylinders to be used, see subsection b.10.

4. **Loading on the New Concrete.** Loading on the new concrete shall be determined by Contractor-made, early break field cured compressive strength cylinders. The Engineer will establish field curing criteria. The required strength for opening to traffic or adjacent paving/backfill strengths shall be at least 75% of the 28-day design strength per Table 1004-1 of the *MDOT 2020 Standard Specifications for Construction*. RCOC shall follow section 706.03 in the *MDOT 2020 Standard Specifications for Construction* or minimum allowable strength in structural, superstructure and substructure concrete for adjacent concrete placement, form removal, and allowable loading. Refer Table 1004-1 of the *MDOT 2020 Standard Specifications for Construction* for minimum compressive strengths of concrete. All compressive strength cylinders to be broken prior to 28 days shall be the responsibility of the Contractor. The early break results shall be submitted to the Engineer electronically or in writing for determination if adjacent work is allowable according to the above referenced standards.

**Table 1: QC Action and Suspension Limits**

<table>
<tr><th>Quality Characteristic</th><th>Action Limits</th><th>Suspension Limits</th></tr>
<tr><td>Air Content (percent)</td><td rowspan="2">See Note 1 Below</td><td>< 5.0 or > 8.5</td></tr>
<tr><td>Air Content Loss (percent)</td><td>Greater than 1.5</td></tr>
<tr><td>Concrete Temp (Deg F)</td><td rowspan="3">As Defined in the Contractor QC Plan</td><td>< 45 or > 90 at time of placement</td></tr>
<tr><td>Slump (Max) (inch)</td><td>See Table 1004-1, footnotes a through l</td></tr>
<tr><td>Density (unit weight)</td><td>N/A</td></tr>
<tr><td>Aggregate Gradation</td><td colspan="2" rowspan="2">Refer to procedure for Optimized Aggregate Gradation included in the Contract.</td></tr>
<tr><td></td></tr>
<tr><td colspan="3">Note:<br>1. Action limits for air content must be defined in the Contractor QC Plan and cannot be <5.5 or>8.0 percent.<br>2. Suspend work if air content is <5.0 or >8.5 percent after pump or paver, regardless of the air content loss.<br>3. Concrete exceeding the maximum specified limit for slump and temperature requirements must be rejected regardless of the total mixing time at the time of arrival to the project.</td></tr>
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## f. Quality Assurance

1. Acceptance sampling and testing will be performed by RCOC using an appropriate, customary, and generally accepted sampling and testing option selected by the Engineer. Individuals performing designated QA tests must be certified concrete technicians through a program certified by the Michigan Concrete Association Level I or II three-year certification program.

2. The Engineer will maintain a complete record of all QA tests and inspections.

The records will contain, as a minimum, signed originals of all QA test results and data. QA test results will be given to the Contractor within 5 working days of request as long as the Contractor has supplied corresponding QC test result to Engineer.

3. Each day of production, the RCOC will determine the number of 28-day compressive strength samples to be taken for each mix type. Acceptance testing will be performed at a minimum frequency of once per day, per mix design.

4. At the option of the Engineer, small incidental quantities, as defined in subsection b.12 of this special provision, may be accepted (visually inspected and noted on the Inspector's Daily Report) without testing for temperature, slump, and air content and daily 28-day compressive strength QA test specimens. One set of compressive strength QA test specimens will be molded along with QA testing for temperature, slump, and air content of fresh concrete for each small incidental quantity per JMF at least once per week during production.

5. The Engineer may require the following corrective action or pay adjustments based on the compressive strength of concrete:

A. Require the Contractor to remove and replace the concrete at no cost to the RCOC or Department, if the compressive strength test result(s) show that the material is more than 500 (PSI) below the required design strength.

B. The Engineer will determine if the concrete has sufficient structural strength and, if so, will adjust the contract unit price for affected pay items and quantity represented based on the following formula, if the tested strength is less than the compressive design strength (CDS):

*Adj. Contract Unit Price = Contract Unit Price - (contract Base Price - Adj. Base Price)*

$$\textit{Adjusted Base Price} = \frac{\textit{Test Strength}}{\textit{CDS}} \times (\textit{contract Base Price})$$

CDS = Compressive Design Strength of *Concrete Mixture*

If the tested strength is greater than CDS, no adjustment will be made.

C. Allow the Contractor to submit a plan, for approval by the Engineer for corrective action to be completed at no cost to the Department. If the plan for corrective action is not approved, f.3.A or f.3.B may be applied.

D. Re-evaluation of Rejectable Concrete will only be considered if the concrete is more than 500 (PSI) below the required design strength, or if the Engineer determines that the concrete does not have sufficient structural strength. If the Engineer determines that re-evaluation is necessary, the contractor will be

required to obtain 6 cores for compressive strength testing. The work will be done in the presence of the Engineer within 45 days from concrete placement The Engineer will take custody of all cores intended for re-evaluation immediately after coring. Based on the core test results, the Engineer may apply f.3.A or f.3.B.

All costs associated with the coring operations and re-evaluation of cores will be at the Contractors sole expense.

6. RCOC shall verify that quality control personnel are on site and performing adequate testing procedures. The RCOC shall also do a side-by-side air content test (ASTM C231 or ASTM C173) to verify that both air meters are in working order. If the pressure meter gauges (ASTM C231) have more than a 0.5% difference, the quality control personnel shall perform the volumetric method (ASTM C173) to determine which gauge is more accurate. The pressure meter reading(s) must be within 0.5% variance from the volumetric reading(s). If not, the volumetric method must be used.

7. Total Air Content requirements for Paver placed or Pumped Concrete. Acceptance of the total air content will be ahead of the concrete paver or pump. The required total air content for acceptance will be 5.0% to 8.5%. In addition, the Contractor must determine the total in place air content after the pump or paver at least once a day, as part of the Quality Control Plan. The target value for in place air content after passing through the paving machine or pump will be 5.5% - 8.0%. Concrete from the same haul unit shall be the material tested for air content both before and after passing through the paver or pump to determine the air loss through the paver or pump. Ensure the air loss through the pump or paver does not exceed the suspension limit defined on Table 1.

If the in place air content is below 5.5% or above 8.0% after it has gone through the concrete paver or pump, the contractor shall adjust the mix to achieve the target in place air content. Adjustments to the mix to achieve the target in place air content shall not cause the total air content to be greater than 8.5% ahead of the paving operation. If the air loss through the paver or pump cannot be controlled within two hours of the first test below 5.5% or greater than 8.0% after material has passed through the paver or pump, or within some other time limit deemed appropriate by the Engineer, the concrete placement operation shall be halted. This time limit may be based upon concrete production rate, the magnitude of deviation from the target in place air content, and the potential for significant quantities of in place, deficient concrete. The Contractor shall then propose mix or construction operation adjustments to the Engineer to reduce the air loss through the paver to no more than 1.5% to achieve the target in place air content and to stabilize the air void system behind the paving machine or pumped concrete.

8. If, during Acceptance testing, the concrete is found to be out of specification for temperature, slump, or air content, the load tested will be rejected and concrete production operations will be stopped. Quality control (QC) personnel will be required

to correct any deficiency found and production will not be allowed to begin until the deficiency, or any additional deficiencies found, has been corrected. Any adjustments to the JMF to bring material within specification shall be approved by Engineer before production will be allowed to resume.

Costs associated with testing or the inability to produce concrete with the specified air content will not be paid. Delays for the same will not be considered for extension of time to the contract.

**g. Measurement and Payment**

The cost associated as described herein shall be included in the respective items of work in which concrete is a material.

1. Base Price.
Price established by the Department to be used in calculating incentives and adjustments to pay items and shown in the contract.