STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SUPPLEMENT 1126
DEVELOPING AND SUBMITTING A PORTLAND CEMENT CONCRETE MIX DESIGN FOR ACCEPTANCE
July 17, 2015

1126.01 Scope
1126.02 Mix Design Submittals for Job Mix Formula (JMF)
1126.03 Documentation and Electronic Submittal Requirements

1126.01 Scope. This Supplement establishes the testing and documentation requirements for portland cement concrete mix designs and procedures for submitting the tested designs for acceptance by the Department. Accepted design submittals are issued a Job Mix Formula (JMF) number in accordance with Item 499 and this Supplement. A JMF number identifies the mix proportions and materials for the concrete that will be used on Department projects. Use only accepted mix designs with an active JMF when providing concrete for a Department project.

Accepted JMFs may be rejected by the Department if performance is inadequate or the mix is not workable or finishable in the field.

1126.02 Mix Design Submittals for Job Mix Formula (JMF). Develop concrete mix designs conforming to Tables 499.03-1 and 499.03-2 and requirements of 499.03. Ensure that the absolute volume of the mix design is 27.0 cubic feet (1.0 cubic meters) at the design air content.

Provide information and data corresponding with the appropriate level of acceptance as follows:

A. New QC 1, QC 2, QC 3 or QC 4 Mix Designs. For new QC 1 thru QC 4 mix designs, develop and test the mix designs according to the following:

1. Concrete Strength. Determine the required average compressive strength ($f_{cr}$) according to ACI 301, section 4.2.3. If no field data is available, select the over-design for the mix from ACI 301, Table 4.2.3.3b. Follow ACI 301 section 4.2.3.4.a or 4.2.3.4.b when using field or laboratory data, respectively, to establish a mix design.

If the laboratory trial mix procedure is used to support the mix design, a single mix may be used if all requirements for the specified mix, including well-graded aggregate, are met. An AMRL accredited laboratory will mix the trial batch, sample and test the specimens (ACI301, 4.2.3.4.b).

If testing in the field, mix a 3 yd$^3$ minimum size load. An ACI Grade 1 Field Testing technician may perform the sampling at the plant if a representative of the AMRL Laboratory witnesses the process. Use 4 x 8 inch (100 x 200 mm) cylinders for the compressive strength testing by the AMRL accredited laboratory.
The water–cementitious ratio (W/Cm) selected using the ACI 301, section 4.2.3.4b method or single mix method becomes the maximum W/Cm ratio for the proposed mix if accepted by the Department.

Test mixes with:

a. The maximum chosen water content
b. Admixtures needed to achieve the maximum slump to within ¾ inch in Table 499.03-3
c. Air content between 6% and 8%.

Measure the slump, air, temperature and yield and produce the strength specimens from the same mix. Test the strength at 3, 7 and 28 days. For QC 4 Mass concrete mixes, if the mix is intended for 56 day acceptance criteria also test compressive strength at 56 days. Determine the aggregate correction factor.

2. Permeability – Obtain samples for determining permeability from the same load as the strength samples. Test the permeability using an AMRL accredited laboratory. Test according to AASHTO T 277, as modified in 499.03.

3. Aggregate Gradation - Use a minimum nominal maximum aggregate size of 1 inch. Proportion the aggregates to provide a well-graded combined gradation within Zone II (Optimal) of the Coarseness Factor Chart shown in Figure 1126.02-1 and as defined in the COMPASS software available at www.pccmix.com.

a. If using software other than COMPASS, contact the Department’s Cement and Concrete Engineer at the Office of Materials Management to receive approval of the software before submitting the mix.

Use the following sieve sizes, as required or used within the gradation range, for the gradation analysis of the aggregates:

<table>
<thead>
<tr>
<th>Required Sieve Sizes for COMPASS input</th>
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<tbody>
<tr>
<td>1½ inch (37.5 mm)</td>
</tr>
<tr>
<td>1 inch (25 mm)</td>
</tr>
<tr>
<td>¾ inch (19 mm)</td>
</tr>
<tr>
<td>½ inch (12.5 mm)</td>
</tr>
<tr>
<td>3/8 inch (9.5 mm)</td>
</tr>
<tr>
<td>#4 (4.75 mm)</td>
</tr>
</tbody>
</table>
Do not eliminate documented sieve sizes within the range of the gradation, even if the size is not part of the standard gradation requirements.

Use aggregates and data only from ODOT certified aggregate suppliers. Use average gradation data based on at least the latest 15 supplier gradation tests.

Figure 1126.02-1,  
Coarseness Factor Chart

In the chart:

The vertical axis is the Workability Factor (%). It is the percent passing the No. 8 sieve for the combined aggregate gradation.

The horizontal axis is the Coarseness Factor (%). It is the combined percent retained above the 3/8” sieve divided by the combined percent retained above the No. 8 sieve. The value is multiplied by 100 to obtain percent

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\text{Coarseness Factor} = \frac{\text{Percent retained above the 3/8 inch (9.5 mm)sieve}}{\text{Percent retained above the #8 (2.36 mm)sieve}} \times (100\%)
\]

4. Mix Design Submittal Information. Submit the following information in accordance with 1126.03:

a. A completed PCC JMF Submittal Form in Excel format. This form is available in at the Department’s website at:
B. Upgrade an Existing QSC1 or QSC2 JMF to a Well-Graded QC 1 or QC 2 JMF without Changes in Cementitious Quantities. Current QSC 1 and QSC 2 with accepted JMFs may be upgraded to a QC 1 or QC 2 JMF if only requesting an aggregate re-proportioning to meet well-graded requirements and no change in the cementitious mass or proportions is being made. Obtain a new JMF by providing the following:

1. Concrete Strength. No strength data is required.

2. Permeability.
   a. For JMFs established under SS 898 requirements, no permeability data is required.
   b. For JMFs established under SS888 requirements, Test the permeability using an AMRL accredited laboratory. Test according to AASHTO T 277, as modified in 499.

3. Aggregate Gradation - Use a minimum nominal maximum aggregate size of 1 inch. Proportion the aggregates to provide a well-graded combined gradation within Zone II (Optimal) as described in section 1126.02.A.3.

4. Mix Design Submittal Information. Submit the following information in accordance with 1126.03:
   a. A completed Appendix A form PCC JMF Submittal Form. This form is available in electronic format at the Departments website at:
      http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/JMF-SUBMITTAL-FORM.aspx
   b. Electronic copies (PDF, Excel, Word…) of the gradation reports for each aggregate and the COMPASS report.
   c. If permeability testing was required, include that certified test data in the submittal

C. Upgrade an Existing QSC1 or QSC2 JMF to a Well-Graded QC 1 or QC 2 JMF with Changes in Cementitious Quantities. Current QSC 1 and QSC 2 with accepted JMFs may be upgraded to a QC 1 or QC 2 JMF with aggregates re-proportioning to be well-graded and with changes the cementitious mass. Obtain a new JMF by providing the following:

1. Concrete Strength. Test mixes with:
   a. The maximum chosen water content
   b. All admixtures required to achieve the maximum slump to within ¾ inch in Table 499.03-3
   c. An air content between 6% to 8%.

   Measure the slump, air, temperature and yield and produce the strength specimens from the same mix. Test the strength specimens for compressive strength at 3, 7 and 28 days. An AMRL accredited lab is not required. Determine the aggregate correction factor.

2. Permeability – Obtain samples for determining permeability from the same load as the strength samples. Test the permeability using an AMRL accredited laboratory. Test according to AASHTO T 277, as modified in 499.
3. Aggregate Gradation - Use a nominal maximum aggregate size of 1 inch. Proportion the aggregates to provide a well-graded combined gradation within Zone II (Optimal) as described in 1126.02.A.3

4. Mix Design Submittal Information. Submit the following information in accordance with 1126.03:
   a. A completed PCC JMF SUBMITTAL FORM. This form is available in electronic format at the Department’s website at:
      http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/JMF-SUBMITTAL-FORM.aspx
   b. Electronic copies (PDF, Excel, Word…) of the certified test data; gradation reports for each aggregate; and the COMPASS report.

D. High-Early Strength Mix Designs, Class QC MS or QC FS. Develop QC MS and QC FS mix designs for acceptance and provide the following data:
   1. Concrete Strength - Determine the center point flexural strength curve for the proposed mix at laboratory temperatures. Test conforming to ASTM C293. An AMRL accredited lab is not required.
      a. Develop a QC MS mix targeted to achieving 400 psi within 24 hours. The Office of Materials Management will accept a mix design achieving 400 psi within 28 hours and issue a JMF.
         (i) Make at least three beam specimens and test them at 20, 24 and 28 hours. Plot the results to produce a curve.
      b. Develop a QC FS mix targeted to achieving 400 psi within 4 hours. The Office of Materials Management will accept a mix design achieving 400 psi within 8 hours and issue a JMF.
         (i) Make at least four beam specimens and test them at 3, 4, 6 and 8 hours. Plot the results to produce a curve
   2. Permeability – Not required.
   3. Aggregate Gradation – Well-graded aggregate - not required. Nominal maximum 1 inch (25 mm) size is required.

4. Mix Design Information. Submit the following information in accordance with 1126.03:
   a. A completed PCC JMF SUBMITTAL FORM. This form is available in electronic format at the Department’s website at:
      http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/JMF-SUBMITTAL-FORM.aspx
   b. Electronic copies (PDF, Excel, Word…) of the certified test data and plotted curve.

E. New QC MISC Mix Designs. For mix designs based on historic Department prescription mixes, provide the following data:
   1. Concrete Strength –The JMF must provide a percent within limits of 85% using methods in Supplement 1127. In lieu of the historic data, provide test results that verify that the strength meets the ACI overdesign requirements for the mix. An AMRL accredited lab is not required.
2. Permeability – Not required.
3. Aggregate Gradation – Use a 1 inch nominal maximum sized coarse aggregate.
4. Mix Design Information. Submit the following information in accordance with 1126.03:
   a. A completed PCC JMF Submittal Form. This form is available in electronic format at the Department’s website at:
   http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/JMF-SUBMITTAL-FORM.aspx
   b. Electronic copies (PDF, Excel, Word…) of the test data.

F. New QC 5 Mix Designs. For mix designs based on historic Department prescription mixes, provide the following data:
   1. Concrete Strength – The JMF must provide a percent within limits of 85% using methods in Supplement 1127. In lieu of the historic data, provide test results that verify that the strength meets the ACI overdesign requirements for the mix. An AMRL accredited lab is not required.
   2. Permeability – Not required.
   3. Aggregate Gradation – Use a 1 or 3/8 inch nominal maximum size coarse aggregate.
   4. Air Content - Provide concrete with an air content of 8±2% when using 3/8 inch nominal maximum size coarse aggregate and 6±2% when using 1 inch nominal maximum size coarse aggregate.
   5. Mix Design Information. Submit the following information in accordance with 1126.03:
      a. A completed PCC JMF Submittal Form. This form is available in electronic format at the Department’s website at:
      http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/JMF-SUBMITTAL-FORM.aspx
      b. Electronic copies (PDF, Excel, Word…) of the test data.

1126.03 Documentation and Electronic Submittal Requirements. Complete the PCC JMF Submittal Form available on the website. Submit with:
   1. Test data of the concrete properties, as required.
      a. PCC JMF Submittal Form batch weights must match the batch weights of the submitted laboratory test data.
   2. If the Aggregate is required to be well-graded.
      a. COMPASS, or other approved software, output showing the individual gradations used and where the combined gradation falls in the Zone II.
      b. The certified aggregate producer’s average of at least their most recent 15 gradation tests for the selected aggregates, not to exceed 18 months from the submittal date, unless approved by the Laboratory.
   3. Any additional test data depending on which mix options above have been selected.
Retesting is required when changing the aggregate type; cement type; or pozzolan class or grade. Changing sources of certified cementitious materials or prequalified admixtures does not require a new JMF number; the sources are to be identified in the submittal, and in the field according to 499.07. The Department is not liable for adverse performance, workability, or finishability effects of any accepted JMF or accepted changes to a JMF.

Complete a PCC JMF Submittal Form when changing aggregate sources of an accepted JMF. Select “MATERIAL CHANGE TO JMF” on the submittal form and include the related JMF that you are using for the aggregate source change. Provide the COMPASS analysis and supporting gradation reports for the new sources, as necessary.

The PCC JMF Submittal Form is available electronically on the Office of Materials Management webpage. Use the most recent version of the form for each submittal and follow the instructions also available on the website.

Submit a completed form and other required data attached electronically to:
dot.cen.pccjmf@dot.state.oh.us

Submit the JMF request at least 20 days prior to expected use. An accepted mix will be issued a JMF number by the Department and the submitter will be notified electronically of the status.