This Materials Method describes specific procedures for field inspecting, sampling, and testing portland cement concrete.
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I. SCOPE

This method describes specific procedures for sampling, and testing portland cement concrete to insure conformance with NYSDOT Standard Specifications, and can be found at www.dot.ny.gov/publications.

- For mix design instructions, refer to Materials Method 9.0, “Proportioning of Portland Cement Concrete.”
- For plant inspection instructions, refer to Materials Method 9.1, “Plant Inspection of Portland Cement Concrete.”

II. GENERAL

Portland cement concrete for use on Department projects must be batched in approved automated Batch Plants, unless otherwise approved by the Regional Materials Engineer. A Concrete Batch Plant Inspector meeting the minimum training requirements as outlined in NYSDOT Materials Procedure 11-01 will be assigned by the Regional Materials Engineer or their representative and will be present during the batching process unless otherwise noted. All concrete must be batched to conform to mix designs prepared or approved by the Department, and all materials used in the production of concrete must appear on the Department’s Approved List of Materials prior to their use. The Approved List is found at www.dot.ny.gov/publications, and is published/updated monthly by the Main Office Materials Bureau. If the material being used is not found on the Approved List, contact the Regional Materials Engineer or their representative, to determine if an approval letter for that material exists.

Concrete must be delivered to the project and point of deposition in approved mixing or haul units, unless otherwise noted. The Contractor is responsible for maintaining a uniform supply of concrete within the requirements of Department Specifications.

Concrete is accepted at the point of deposition based upon test results, visual observations, and conformance with NYSDOT Standard Specifications.

Project Inspectors are responsible to verify concrete placement procedures and testing the plastic concrete, and must meet the minimum training requirements as outlined in NYSDOT Materials Procedure 02-02, and NYSDOT Independent Assurance Sampling and Testing Manual and is found at www.dot.ny.gov/publications. They are also responsible for following the inspection program prescribed in this method. These procedures are intended to give maximum assurance that a quality product will result and perform well throughout its designed life.

Concrete mixing and delivery systems typically used on Department projects are defined as follows:

1. **Truck Mixed Concrete** - This is defined as concrete mixed on the project in a truck mixer. The cement, aggregates and admixtures are batched at a plant and hauled to the project in an approved truck mixer. Mixing water is from a tank on the truck and all mixing occurs at the placement site. This type of mix is utilized for projects requiring long haul times between the Batch Plant and project site.
2. **Transit Mixed Concrete** - This is defined as concrete mixed at the plant or in transit to the project in an approved truck mixer. The cement, aggregates, admixtures, and water are batched at the concrete plant and mixing commences shortly after batching.

3. **Central Mixed Concrete** - This is defined as concrete mixed completely in a stationary mixer at the concrete plant. The mixed concrete is hauled to the project in either truck mixers or open haul units.

4. **Mobile Concrete Mixing Units** – This is defined as concrete that is completely mixed in a mobile concrete mixing unit on the project site. Cement, aggregates, admixtures and water are stored in separate compartments on the mixing unit and are batched and mixed at the discharge chute. A satisfactory calibration (proportioning) of the different ingredients must be demonstrated before actual placement of concrete. For calibration, see Materials Method 9.4 and NYSDOT Standard Specifications Section 501-2.04.

III. **CONCRETE SPECIFICATIONS, REQUIREMENTS, AND GUIDELINES**

A. **General**

The specifications and guidelines for concrete vary depending upon the nature of the work. An Inspector, in order to be effective, must be aware of all the pertinent requirements that affect the work.

B. **Information Sources**

1. Project Plans and Proposal; Plans and location for work, also may include modifications to Payment Items and Special Requirements.

2. Payment Items; Description of work, materials required, Construction Details, Methods of Measurement, and Basis of Payment.


IV. INSPECTION CHECKLISTS

Use the following abbreviated checklist as a guide prior to inspecting a given concrete operation:

1. Mixing Equipment Checklist

   See Tables 1-A and 1-B (next page) for detailed check lists.

2. Concrete
   a. Concrete Class and Item
   b. Slump Requirements
   c. Air Content Requirements
   d. Approximate Water Requirements
   e. Admixture Requirements

3. Sampling and Testing
   a. Sampling Technique
   b. Sampling Rate
   c. Tests Required
   d. Acceptance and Corrective Action Procedures

4. Documentation
   a. Delivery Ticket Requirements
   b. Field Forms
   c. AASHTO SiteManager test cylinder data entry
### TABLE 1-A

**CONCRETE MIXER AND DELIVERY UNIT CHECKLIST**

<table>
<thead>
<tr>
<th>ITEMS TO BE CHECKED *</th>
<th>TRUCK MIX</th>
<th>TRANSIT MIX</th>
<th>CENTRAL MIX***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hauled in Truck Mixers</td>
<td>Hauled in Open Units</td>
<td></td>
</tr>
<tr>
<td>Approved Mixer, Haul Unit **</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Batch Size</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Revolution Counter Working Properly</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water System Operating Properly</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Haul Time</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mixing Time</td>
<td>X</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mixing Drum Speed</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Agitating Drum</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Number Mixing Revolutions</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Proper Mixing after Water Additions</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Discharge Time</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Discharge Procedure</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Delivery Ticket</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

* The requirements for concrete documentation, which are contained in MURK and NYSDOT Standard Specifications, will govern the minimum frequency for checking items such as time and mixing revolutions.

** Must have current Department identification seal (BR 275) placed in a protected location on delivery/mixing units to indicate approval, unless otherwise authorized by the Regional Materials Engineer.

*** If water is to be added to the mix after batching, requirements of approved truck mixer applies.

### TABLE 1-B

**MOBILE CONCRETE MIXING UNIT CHECK LIST**

<table>
<thead>
<tr>
<th>ITEMS TO BE CHECKED</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing unit clean</td>
<td>X</td>
</tr>
<tr>
<td>Aggregates gates set properly</td>
<td>X</td>
</tr>
<tr>
<td>Mix-water dial is set correctly</td>
<td>X</td>
</tr>
<tr>
<td>Cement-meter-feeder clean</td>
<td>X</td>
</tr>
<tr>
<td>Meter register is operating properly</td>
<td>X</td>
</tr>
<tr>
<td>Water system is okay</td>
<td>X</td>
</tr>
<tr>
<td>Air system is okay</td>
<td>X</td>
</tr>
<tr>
<td>Mix conveyor is okay</td>
<td>X</td>
</tr>
<tr>
<td>Aggregates okay</td>
<td>X</td>
</tr>
<tr>
<td>No wet or dry pockets in aggregates</td>
<td>X</td>
</tr>
<tr>
<td>Correct cement</td>
<td>X</td>
</tr>
</tbody>
</table>

Also see NYSDOT Materials Method 9.4
V. SAMPLING AND TESTING FREQUENCY

A. General

The program for sampling and testing plastic portland cement concrete varies with the type of concrete application. The two major types are structural concrete and pavement concrete (see Table 2, on Page 6). The slump and air content test, which are required for the “Control Series,” are the most frequently conducted field tests. When compressive strength cylinders are cast for structural concrete, slump test, air content test, and concrete and air temperatures are also required for each set. These tests make up the “Cylinder Series.”

Since sampling procedures affect test results, it is extremely important that you strictly adhere to SECTION- A.

B. Routine Testing

The schedule for routine sampling and testing of structural and pavement concrete is described in Tables 2, 3 and 4 on Pages 6 and 7.

C. Special Testing

1. Yield Tests

There are no prescribed requirements for yield tests, however, they should be conducted when problems concerning yield arise.

The Regional Materials Engineers have the equipment to conduct these tests. See SECTION- G for detailed procedures.

2. Uniformity Tests

Prescribed requirements for uniformity tests are outlined in NYSDOT Standard Specification Section 501, and Materials Method 9.1. Tests will be conducted when requests are made to reduce (Central Mixed Concrete) mixing times, or where required by Specifications.

In the Specifications for haul units and conveyance systems, where uniformity requirements are included, the tests will be conducted only when deemed necessary by the Engineer. If routine testing or visual observations show non-uniform concrete production, then the Engineer should have uniformity tests conducted. An abbreviated uniformity test consisting of a series of slump and air content tests on “front” and “back” samples may be substituted for the complete test series at the option of the Engineer. (See SECTION- I)

3. Early Strength Determinations

When it is desired to obtain concrete strength results earlier than the normal 28 day period, arrangements should be made with the Regional Materials Engineer.
### TABLE 2
CONCRETE TESTING REQUIREMENTS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CONTROL SERIES</th>
<th>CYLINDER SERIES*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slump/Air</td>
<td>Slump/Air/Temperature and Cylinders</td>
</tr>
<tr>
<td><strong>STRUCTURAL CONCRETE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box Culverts</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bridge Sidewalks</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Catch Basins</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Concrete Riprap</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Concrete Median Barrier</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Curbs</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Deck Slabs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drop Inlets</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Field Inlets</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Footings</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gutters</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Headwalls</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Lighting Structure Foundations</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Manholes</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Pedestals</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Piers</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Piles</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Prestressed, Precast (Structural)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rigid Frames, Arches</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Sign Foundations</td>
<td>X</td>
<td>X**</td>
</tr>
<tr>
<td>Tremie</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Walls</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>PAVEMENT CONCRETE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Driveways</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pavement</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Pavement Foundations</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Pipe Invert</td>
<td>X</td>
<td>-</td>
</tr>
</tbody>
</table>

* Cylinders may be cast for any type of concrete work when the Engineer desires strength information.

** Cylinders are not required for foundations for ground mounted signs when the sign area is 40 ft² or less.
TABLE 3
STRUCTURAL CONCRETE TESTING RATES

<table>
<thead>
<tr>
<th>TEST SERIES</th>
<th>TESTS *</th>
<th>MINIMUM TESTING RATE **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Series</td>
<td>Slump and Air</td>
<td>1 set of tests from each structural component and thereafter at a rate of 1 set per ±50 yd³ for the duration of that placement.</td>
</tr>
<tr>
<td>Cylinder Series</td>
<td>Slump, Air, Temperature, and Cylinders</td>
<td>1 set of tests from each structural component and thereafter at a rate of 1 set per ±200 yd³ for the duration of that placement.</td>
</tr>
</tbody>
</table>

TABLE 4
PAVEMENT CONCRETE TESTING RATES

<table>
<thead>
<tr>
<th>TEST SERIES</th>
<th>TESTS *</th>
<th>MINIMUM TESTING RATE **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Series</td>
<td>Slump and Air</td>
<td>1 set of tests from the first placement of each day and thereafter at a rate of 1 set per 150 to 200 yd³.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(150 yd³ is equivalent to a 450 feet long by 12 feet wide by 9 inch thick pavement).</td>
</tr>
</tbody>
</table>

* See the following Sections for detailed instructions:

** Conventional PCC
- Sampling: SECTION -A
- Temperature: SECTION -B
- Slump: SECTION -C
- Air Content: SECTIONS -D and F
- Unit Weight: SECTION -G
- Cylinders: SECTION -H
- Uniformity: SECTION -I

** Self-Consolidating (SCC)
- Sampling: SECTION -A
- Temperature: SECTION -B
- Air Content: SECTIONS -D and F (with modifications on page 47)
- Unit Weight: SECTION -G (with modifications on page 47)
- Cylinders: SECTION -H (with modifications on page 47)
- Slump Flow: SECTION -J
- Visual Stability Index: Table J-1 (page 50)

** Rate of testing may be increased whenever an indication of non-acceptable concrete is noticed, or as directed by the Engineer.

PRECAST CONCRETE (QC/QA Program)
Follow the “Department’s” approved Precast Plant quality control plan for testing frequency and requirements, or as directed by the Director, Materials Bureau.
VI. ACCEPTANCE PROCEDURES

Acceptance is based on field tests results of plastic concrete. Batches or loads will be rejected whenever the results of slump and air content tests exceed specification limits.

Every effort should be made to obtain test results before the concrete is in its final position. If non-acceptable concrete test results are noted, then subsequent loads or batches should be tested.

Pavement Concrete is typically accepted based on the results of the slump and air content tests. Cores are taken from the completed pavement section to verify thickness requirements. However test cylinders may be cast, at the request of the Engineer.

The Engineer is responsible for proper testing and determining acceptance and rejection of concrete based upon the general instructions in this manual and project specifications. Notify the Batch Plant as soon as possible to correct any non-acceptable concrete, as well as any other information which may affect subsequent production.

VII. DOCUMENTATION

The Inspector is responsible for documenting certain pertinent aspects of the work. This includes recording the inspection of concrete placement procedures and the results of field tests.

The detailed requirements and instructions for concrete placement procedures are included in the Department’s “Manual for Uniform Recording Keeping” (MURK), found at www.dot.ny.gov/publications.

The detailed requirements and instructions for concrete field test results are found within the Departments AASHTO SiteManager Quick Reference Guide, listed under “plastic concrete” or may be accessed at https://www.dot.nys.gov/main/business-center/trns-port/repository/QRG-Plastic_Concrete.pdf.
SECTION- A
CONCRETE SAMPLING PROCEDURES
ASTM C172/C172M

I. SCOPE

This method describes the procedures to follow when sampling fresh portland cement concrete for routine field tests. It includes procedures for sampling from revolving drum truck mixers, mobile-concrete mixing units, and open top haul units.

II. GENERAL

Inspectors are often pressured to obtain a concrete sample as quickly as possible when concrete is first discharged. However, to obtain a representative sample, allow at least 10% of the batch to be discharged. No sample should be taken after 90% of the load has been discharged. Material used for one test may not be used for another test, with the exception of the temperature test.

Specifications require compressive strength cylinders to be made approximately every 200 yd³. Since the minimum 1 ft³ concrete sample represents less than 0.02% of the concrete placed, the need for a representative sample becomes very apparent. Therefore, do not obtain samples from the beginning or last part of the batch discharge. Every precaution should be made to protect that sample from the damaging effects of evaporation and contamination.

III. EQUIPMENT

1. Container for transporting the sample to the test site.
2. Shovel or scoop for re-mixing the concrete.
3. A clean piece of dampened plywood, or other rigid non-absorbent surface.

IV. SAMPLING PROCEDURES

Sample the concrete after discharge from the mixing or hauling equipment and just prior to any additional manipulation. A sample to be used for casting cylinders must consist of two or more portions taken at regularly spaced intervals from the middle portion of the batch by diverting the concrete stream directly into the transport container, unless otherwise noted (see Table A-1, next page).

- Do not exceed 15 minutes between obtaining the first and final portions of the composite sample.
- Transport individual samples to the place where the tests are to be performed and protect the samples from evaporation and contamination. Combine the two or more samples, and re-mix to form a composite sample.
- Start tests for temperature, slump and air content within 5 minutes after obtaining the composite sample.
- Start molding compressive strength test cylinders within 15 minutes after obtaining the composite sample.
V. **SAMPLE SIZE**

The total sample size should be large enough so that no concrete used in one test has to be reused in another test. The minimum sample size for compressive strength tests (Cylinder Series) is 1 ft³. The minimum sample size for routine slump and air content tests (Control Series) may be less. *Approximately one-quarter of the total sample should be excess after all tests are conducted.*

### TABLE A-1
CONCRETE SAMPLING PROCEDURES

<table>
<thead>
<tr>
<th>MIXING/HAULING EQUIPMENT</th>
<th>TEST SERIES (See Sample Size)</th>
<th>SAMPLING PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revolving Drum Truck Mixers</td>
<td>Control Series</td>
<td>Obtain samples from two or more portions of the batch and combine to obtain a composite sample.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do not sample at the very beginning or end of the batch. Sample by completely diverting the stream so that it discharges into a container or by repeatedly passing a receptacle through the entire discharge stream.</td>
</tr>
<tr>
<td></td>
<td>Cylinder Series</td>
<td>Same as above, except obtain a composite sample from the middle third of the batch.</td>
</tr>
<tr>
<td>Mobile Concrete Mixing Units</td>
<td>Control Series</td>
<td>Obtain samples from initial portion of the load.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do not sample from the first 1-2 ft³ of the load. Sample by diverting the stream so that it discharges into a container.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fill, consolidate, and strike off the air pot within 3 minutes of sampling.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay the slump test for 3 to 5 minutes after sampling.</td>
</tr>
<tr>
<td></td>
<td>Cylinder Series (Requires two or more inspectors to meet time requirements)</td>
<td>Same as above.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Same as above.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fabricate the cylinders within 3 minutes of sampling.</td>
</tr>
<tr>
<td>Open Top Haul Units</td>
<td>Control Series or Cylinder Series</td>
<td>Obtain two or more samples and combine to form a uniform composite sample.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The sample may be obtained on the grade, after the spreading operation.</td>
</tr>
</tbody>
</table>
SUMMARY

CONCRETE SAMPLING PROCEDURES
(Revolving Drum Truck Mixer)

1. **Control Series:** Do not sample before 10% of the load has been discharged.
   
   **Cylinder Series:** Sample from middle of batch at two or more regularly spaced intervals to form a composite sample.

2. The minimum size of the composite sample is 1.0 ft³ when test cylinders are to be molded. The sample size for routine slump and air content tests may be less.

3. The maximum allowable time between obtaining the first and final portions of the composite sample is 15 minutes.

4. Obtain a representative sample by completely diverting the discharge stream into a sample container or by repeatedly passing a receptacle through the discharge stream.

5. Transport sample to where the tests are to be performed.

6. Combine and re-mix to form a composite sample.

7. Protect the concrete sample from sun, wind, rapid evaporation, and contamination.

8. Start the tests for slump, temperature, and air content within 5 minutes after obtaining the final portion of the composite sample.

9. Start molding the test cylinders within 15 minutes after obtaining the final portion of the composite sample.
I. SCOPE

This test method describes the procedure for determining the temperature of freshly mixed portland cement concrete.

II. GENERAL

Concrete temperature is a highly important factor in influencing the quality, time of set, and strength of portland cement concrete. When water comes into contact with the portland cement a chemical reaction occurs which generates heat. As the concrete begins to set, the temperature will increase with time, therefore it is important to monitor concrete temperature as discharge time increases.

Concrete with a high initial temperature will usually have a higher than normal early strength, a lower than normal strength later, and the overall quality of the concrete will generally be lower. Concrete placed and cured at low temperatures will develop strength at a lower rate, but ultimately have a higher strength. Concrete temperature also affects the performance of chemical admixtures, including air entraining agents, and other performance additives.

The temperature of the concrete, and the ambient air temperature, specifies what type of curing and protection will be required, and the length of time that it should be maintained.

III. EQUIPMENT

1. Temperature Measuring Device (thermometer) - use to measure the temperature of freshly mixed portland cement concrete to ± 1°F with a range of 30°F to 120°F.

   Glass thermometers conforming to ASTM specifications are satisfactory. Other thermometers of the required accuracy, including metal immersion type, are acceptable. The design shall be such that it allows a minimum of 3 in. immersion into the concrete sample during operation.

   Calibrate thermometers in accordance with ASTM C1064/C1064M, annually or whenever there is a question about its accuracy.

2. Container - made of a non-absorbent material and large enough to provide at least 3 in. of concrete cover in all directions around the sensor.

   The temperature may be measured in the transporting equipment, provided there is adequate cover in all directions, or it may be taken from the concrete placement directly within the forms.

   If the sample is small enough to gain or loose significant heat to its surroundings during time of testing, the result will not be representative of the concrete mass.
IV. SAMPLING

Sample the freshly mixed concrete in accordance with SECTION-A. If the only purpose is to determine the concrete temperature, a composite sample is not required.

V. TEST PROCEDURE

- Place the thermometer in the sample so that the sensing portion has a minimum of 3 in. cover in all directions.

- Gently press the concrete around the thermometer at the surface of the concrete so that the ambient air temperature does not affect the reading.

- Leave the thermometer in the freshly mixed concrete for a minimum of 2 minutes, but not more than 5 minutes.

- While the thermometer is still in the concrete, read the temperature to the nearest 1°F.

- Record the temperature reading to the nearest 1°F.
I. SCOPE

This test method describes the procedure for determining the slump of plastic portland cement concrete.

II. GENERAL

The slump test is a measure of the consistency or stiffness of plastic portland cement concrete. It is an indirect measure of the amount of water within a mix (water/cement ratio). However, with mixes containing admixtures, such as high range water reducers and retarders, this test is not a good indicator for “measuring” water/cement ratios.

Under laboratory conditions with strict control of all concrete materials, increases in water content will typically: increase slump, lower strength, lower durability, and cause the mix to segregate.

A sample of freshly mixed concrete is placed in a standard mold shaped as a frustum of a cone, and compacted using a tamping rod in a prescribed manner. The cone is then removed and the concrete is allowed to settle. Then, the vertical distance is measured between the top of the slump cone and the original displaced center of the settled concrete. This measurement is reported as the slump of the concrete.

This test method is considered applicable to plastic concrete having coarse aggregate up to 37.5 mm (1½ in.) in size. If the coarse aggregate is larger than 37.5 mm (1½ in.) in size, wet sieve the sample and perform the test on the portion of the concrete passing the 37.5 mm (1½ in.) sieve.

Concrete having a slump less than ½ in. may not be adequately plastic and concrete having a slump greater than 9 in. may not be adequately cohesive. In these conditions this test is not applicable, and caution should be exercised in interpreting such results.

III. SAMPLE

Obtain a representative sample in accordance with “SECTION-A, CONCRETE SAMPLING PROCEDURES.”
IV. EQUIPMENT

1. Mold - a standard slump cone as defined in ASTM C143/C143M, with a base diameter of 8 in., a top diameter of 4 in., and a height of 12 in.

2. Tamping rod - a round, straight steel rod $\frac{5}{8} \pm \frac{1}{16}$ in diameter. The length shall be at least $4 \pm \frac{1}{8}$ in. greater than the depth of the mold, but not greater than $24 \pm \frac{1}{8}$ in., with the tamping or both ends rounded to a hemispherical tip.

3. A moist, non-absorbent, firmly supported level surface, free of vibrations.

4. A small metal scoop of appropriate size used to fill the mold so that concrete is not excessively spilled during placement into the mold.

5. Measuring Device – a ruler, metal roll-up measuring tape, or rigid or semi-rigid measuring instrument marked in increments of $\frac{1}{4}$” or less.

V. TEST PROCEDURE

1. Dampen the tamping rod, scoop, and inside of slump cone with a damp cloth or sponge.

   Place slump cone on a level, moist, non-absorbent surface that is firmly supported and free from vibrations.

   Firmly hold the slump cone in place by standing on the foot pieces. Do not remove your weight from the foot pieces at anytime during filling of the cone. If the cone moves in any way, the test is considered invalid and should be performed again using another portion of the sample.

2. Fill the cone in three layers. Each layer equals one third of the volume of the slump cone. Place the concrete in the cone using the scoop while moving it around the perimeter of the top to ensure even distribution of the concrete.

   **NOTE:** One-third of the volume of the slump cone fills it to a depth of approximately 2 $\frac{5}{8}$ in. Two-thirds of the volume, fills it to a depth of approximately 6 $\frac{1}{8}$ in.
3. Using the rounded end of the tamping rod, rod each layer with 25 strokes, uniformly distributing the strokes over the cross-section of each layer.

For the bottom layer, this will necessitate inclining the rod slightly and making approximately half of the strokes near the perimeter and then progressing with vertical strokes spirally toward the center. Rod the bottom layer throughout its full depth without forcibly striking the base.

4. Rod the second layer and subsequently the third layer throughout its depth, penetrating approximately 1 in. into the underlying layer.

When filling the top layer, heap the concrete above the cone before rodding. While rodding the top layer, keep excess concrete above the top of the cone at all times. This may require adding more concrete to the cone after the rodding process has begun. If this situation occurs, continue the rodding count from the value reached before adding more concrete, but never exceeding a total of 25 rod penetrations.

5. After rodding the top layer, strike off the concrete by means of a screeding and rolling motion of the tamping rod with no further tamping or compacting the material.

Clear away any spilled concrete from around the base of the slump cone.
6. Press down firmly on the slump cone handles and remove your feet from the foot pieces.

7. Raise the slump cone vertically 12 in. in 5 ± 2 seconds with a steady upward lift with no lateral or torsional motion.

Complete the entire operation without interruption from the start of filling through removal of the slump cone within an elapsed time of no more than 2½ minutes.

8. Immediately measure the slump to the nearest ¼ in. from the top of the slump cone to the original displaced center of the specimen. Record the results.

NOTE: If the concrete falls away or shears off from one side or portion of the mass, disregard the test and perform a new test on another portion of the composite sample.

If two consecutive tests show a falling away or shearing off, the concrete probably lacks the necessary plasticity and cohesiveness for the slump test to be applicable. Notify the Engineer.

– CLEAN YOUR EQUIPMENT –
SUMMARY

SLUMP TEST

1. Start the test within 5 minutes after obtaining and re-mixing the final portion of the composite sample.
2. Dampen the tamping rod, scoop, slump cone, and non-absorbent surface with a damp cloth or sponge.
3. Hold the slump cone firmly against the base by standing on the foot pieces. Do not allow the slump cone to move during the filling or rodding process.
4. Fill the slump cone using the scoop in approximately 3 equal layers by volume. Move the scoop around the top perimeter of the cone while filling to insure even distribution of the concrete. (First layer approximately 2\(\text{e}\) in. Second layer approximately 6\(\text{c}\) in.).
5. Rod each layer 25 times with the rounded end of the tamping rod. Distribute the strokes uniformly over the cross section of each layer. Rod the first layer full depth without forcibly striking the bottom, rod the second and third layers to penetrate the underlying layer approximately 1 in.
6. When rodding the top layer, keep excess concrete above the top of the cone at all times.
7. Strike off the concrete level with the top of the cone using the tamping rod with a screeding and rolling motion. Clear away any spilled concrete from around the base of the slump cone.
8. While pressing down firmly on the slump cone handles, remove your feet from the foot pieces, and lift the slump cone in one smooth motion, without twisting, in 5 ± 2 seconds.
9. Place the slump cone next to the displaced concrete specimen and immediately measure the vertical distance from the top of the slump cone to the top of the original displaced center of the specimen.
10. Record the measurement to the nearest ¼ in.
11. If the concrete falls away or shears off from one side or portion of the mass, disregard the test and perform a new test on another portion of the composite sample. If two consecutive tests show a falling away or shearing off, the concrete probably lacks the necessary plasticity and cohesiveness for the slump test to be applicable.
12. Perform the entire test from start to finish within 2½ minutes.
SECTION- D
AIR CONTENT TEST PROCEDURE - PRESSURE METHOD
ASTM C231/C231M

I. SCOPE

This test method describes the procedure for determining the air content of freshly mixed portland cement concrete using the “Type B” pressure meter.

II. GENERAL

This method determines the total air content of freshly mixed portland cement concrete by allowing a known volume of air at a certain initial pressure to expand into a container filled with fresh concrete, thereby compressing the air. The amount of air in the concrete is proportional to the decrease in pressure and is read directly from a gauge as percent air.

This test method is intended for use with portland cement concrete or mortars made with relatively dense aggregates. The test determines the air content of freshly mixed concrete exclusive of any air that may be inside voids within the aggregate particles. For certain dense aggregates, an aggregate correction factor* must be applied to allow for these voids.

This test method is not applicable to concrete made with lightweight coarse aggregates, such as air-cooled blast-furnace slag or other highly porous aggregates. This test method is also not applicable to non-plastic concrete that is commonly used in the manufacture of concrete pipe and concrete masonry units.

* Typically, all aggregates used in NYSDOT mixes do not require the use of this factor. However, the aggregate correction factor may be determined in accordance with ASTM C231/C231M.

III. SAMPLE

Obtain a sample in accordance with “SECTION-A, CONCRETE SAMPLING PROCEDURES.”

IV. EQUIPMENT

The equipment described below is a “Type B” pressure meter. This meter is generally used by the Department and typically called the Pressure-Ur-Meter. Other meters meeting the requirements of ASTM C231/C231M are acceptable, as approved by the Director, Materials Bureau.

1. Base Container - cylindrical in shape, made of steel or other durable material, having a capacity of at least 0.20 ft³. However, the air meters used by the Department typically have a capacity of approximately 0.25 ft³. The bowl must be flanged or constructed to provide a watertight seal between the base and top section. The inside surface of the bowl, rim, flanges, and other component fitted parts must be machined smooth.
2. **Cover Assembly** - made of steel or other durable material, flanged or constructed to provide a watertight seal between the top and base section. The interior surfaces must be machined smooth and contoured to provide an air space above the level of the top of the measuring bowl.

The cover assembly includes:
- Air chamber.
- Pump for pressuring the air chamber.
- Valve for bleeding off air pressure from within the air chamber.
- Needle valve which will release air pressure from the air chamber into the base container.
- Petcocks for relieving the air pressure from within the base container.
- Special pressure gauge calibrated to read the percent air directly.

3. **Calibration Vessel** - a cylindrical container having an internal volume equal to a percent of the volume of the measuring bowl, typically equal to 5% air.

4. **Calibration Tubes** - straight, and curved tubing, threaded on one end.

5. **Miscellaneous Equipment**
   - **Scoop** - a small metal scoop of appropriate size used to fill the base container.
   - **Tamping Rod** - a round, straight steel rod ¾ in. ± 1/16 in diameter. The length shall be at least 4 ± 1/8 in. greater than the depth of the mold, but not greater than 24 ± 3/8 in, with the tamping or both ends rounded to a hemispherical tip.
   - **Mallet** - with a rubber or rawhide head weighing 1.25 ± 0.50 lb.
   - **Strike-Off Bar** - a flat straight steel bar or other suitable material at least ¾ in. thick and 3/4 in. wide by 12 in. long.
   - **Strike-Off Plate** - a flat rectangular plate at least 2 in. greater in width than the diameter of the base. Typically, the Department uses an acrylic plastic plate with a minimum thickness of ½ in. The edges of the plate must be straight and smooth within a tolerance of 1/16 in.

V. **MAINTENANCE AND REPAIR**

It is essential to clean the air meter thoroughly after each use, making sure that all valve orifices are clean. It is also very important not to damage the top surface of the meter base during cleaning. If this surface is damaged, the top section will fail to have an adequate seal while performing the test.

The air meter should be transported in its case to protect it from damage.

Minor repairs, such as replacement of gaskets, petcocks, gauges, etc., should be done by Regional Materials Bureau personnel. Replacement parts for the air meter are available from the Regional Materials Engineer or the Materials Bureau in Albany, N.Y. When requesting parts, please include the part number and the part name. See drawing of the meter (next page) for replacement parts list.
## MM 9.2
FIELD INSPECTION OF PORTLAND CEMENT CONCRETE

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<thead>
<tr>
<th>PART NUMBER AND NAME</th>
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<tr>
<td>1. PRESSURE CHAMBER</td>
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<td>2. PRESSURE CHAMBER CAP</td>
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<td>3. PRESSURE CHAMBER ELBOW</td>
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<td>4. PRESSURE CHAMBER GASKET</td>
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<td>5. PRESSURE CHAMBER AIR RELEASE STEM</td>
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<td>6. PRESSURE CHAMBER AIR RELEASE CAP</td>
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<td>6A. RELEASE CAP GASKET</td>
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<td>7. COMPLETE GAUGE</td>
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<td>11. NEEDLE VALVE STEM</td>
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<td>13. NEEDLE VALVE LEVER</td>
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<td>14. NEEDLE VALVE SPACER</td>
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<td>15. NEEDLE VALVE &quot;O&quot; RING</td>
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<td>28. TOGGLE LOCK NUT</td>
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<td>29. BASE</td>
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<td>30. BASE HANDLE</td>
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<td>31. CALIBRATING VESSEL</td>
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<td>32. CALIBRATING TUBE (OUTER)</td>
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<td>33. CALIBRATING TUBE (INNER)</td>
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<td>34. STRIKE OFF BAR</td>
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<td>35. TAMING ROD</td>
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<td>36. SYRINGE</td>
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<td>37. GAUGE GLASS</td>
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<td>38. CARRYING CASE</td>
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<td>42. CLAMP STUD</td>
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<tr>
<td>54. PUMP PISTON ASSEMBLY</td>
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VI. AIR CONTENT - TEST PROCEDURE

1. Dampen the inside of the air meter base with a damp cloth or sponge and then fill it one-third full with concrete that has been properly sampled and re-mixed. Rod this layer throughout its depth with 25 strokes using the rounded end of the tamping rod, evenly distributed over the cross-section without forcibly striking the bottom.

2. After rodding, rap around the sides of the container smartly 10 to 15 times with the mallet to close the voids left by the tamping rod.

3. Fill the base container two-thirds full and rod 25 times, evenly distributing the strokes over the cross-section and penetrating into the layer below approximately 1 in. Rap around the sides of the container with the mallet smartly 10 to 15 times with the mallet to close the voids left by the tamping rod.

4. Slightly overfill the container when placing the top layer. Rod 25 times, penetrating into the layer below approximately 1 in. While rodding the top layer, keep excess concrete above the top of the cone at all times. This may require adding more concrete after the rodding process has begun. If this situation occurs, continue the rodding count from the value reached before adding more concrete, but never exceeding a total of 25 rod penetrations. Rap around the sides of the container with the mallet, as before.
5. Remove the excess concrete by sliding the **strike-off bar** across the top flange with a sawing motion until the bowl is level full.

**NOTE**: When using the base of the air meter to perform a unit weight test, use a strike-off plate. See *SECTION -G*.

6. Dampen the inside of the cover with a damp cloth or sponge. Clean off the top edge/rim of the base container, and clamp the cover on with both petcocks open. Close the clamps opposite each other simultaneously.

7. Inject water through one of the petcocks with the syringe until water flows out the other petcock free of air bubbles. While injecting the water, tap the container cover gently with the mallet to insure removal of all trapped air from the top of container.
8. Leaving both petcocks open, pump up the pressure in the air chamber to slightly beyond the proper initial line.

**NOTE:** If the initial line is not known, calibrate the meter according to SECTION-E “AIR PRESSURE METER CALIBRATION”.

9. Allow a few seconds for the compressed air to cool to normal temperature, and then bring the gauge needle to the proper initial pressure line by pumping up or bleeding off air and tapping the gauge lightly with your fingers.

10. Close both petcocks and depress the main air valve thumb lever to release air into the base container. Strike the sides of the air pot smartly with a mallet to relieve any restraints. With the thumb lever still depressed, tap the gauge lightly with your fingers and allow the gauge needle to stabilize. Do not tilt the meter at anytime. Read the percent of air indicated on the gauge to the nearest 0.1%, or to the nearest ½ scale division if gauge reading exceeds 8%.

* **Air content** = (meter reading) - (aggregate correction factor, if required).

* **Record the test value.**

11. Release the pressure in the container by opening both petcocks slowly and remove the cover.

**NOTE:** After the top section is thoroughly clean, depress the main air valve thumb lever to release air through the valve opening to dislodge any concrete material that may be lodged in the needle valve assembly in the base of the cover, the gauge needle will return to the “free zone” or past the 100% mark on the gauge.

– CLEAN YOUR EQUIPMENT –
1. Re-mix the composite sample.
2. Dampen the inside of the base with a damp cloth or sponge.
3. Fill the base in approximately 3 equal layers.
4. Rod each layer 25 times, distributing the strokes uniformly over the cross section of each layer. Rod the first layer full depth, rod the second and third layers to penetrate the underlying layer approximately 1 in.
5. Rap around the side of the container 10 - 15 times with the mallet after rod ding each layer to close any voids left by the rod.
6. Strike off the excess concrete using the screed bar or a strike-off plate until level with the top of the container.
7. Clean the top edge/rim of the base container.
8. Moisten the inside of the cover with a damp cloth or sponge and with both petcocks open, clamp it to the base, clamping opposite clamps simultaneously.
9. Inject water through one petcock until it flows freely out the other petcock. While injecting the water, tap the sides of the container cover gently with the mallet to insure removal of all trapped air from the top of the container.
10. Leaving both petcocks open, pump up the air chamber to slightly above the initial line.
11. Allow a few seconds for the compressed air to stabilize. Adjust the gauge to the initial line.
12. Close both petcocks.
13. Depress the main air valve thumb lever to release air into the base container, and strike the sides of the air pot base smartly with a mallet to relieve any restraints.
14. While holding down the thumb lever, tap the gauge lightly with your fingers to stabilize the needle. Do not tilt the meter at anytime.
15. Read the percent air to the nearest 0.1 % or to the nearest ½ scale division if gauge reading exceeds 8%.
16. Release the main air valve thumb lever, open both petcocks slowly to release the pressure within the base, and remove the cover. After the cover has been removed, depress the main air valve thumb lever to release the pressure from the air chamber.
17. Calculate the air content:
   \[
   \text{Air content} = (\text{meter reading}) - (\text{aggregate correction factor, if required}).
   \]
18. Record the air content reading.
A. General

The calibration procedure described below is for the “Type B” Pressure Meter, typically used by the Department. Calibrate other types by following the instructions supplied by the Manufacturer.

**Note:** The use of calibration canisters or other similar devices is not an acceptable method of calibrating the air meter.

The calibration of the air meter involves filling the base with water and then removing known volumes of water and adjusting the gauge, if necessary, to read corresponding percentages of air. Calibrate the air meter when it is initially received on the project and periodically throughout the construction season, or when there is a suspected problem.

B. Procedure

1. Fill the base full of water. Screw the short piece of straight tubing into the threaded petcock hole on the underside of the cover. Clamp the cover on the base with the tube extending down into the water.

2. With both petcocks open, inject water with the syringe through the petcock with the extension tube underneath until all air is forced out the opposite petcock. While injecting the water, tap the side of the container gently with the mallet to insure removal of all entrapped air from the top of the container. Leave both petcocks open.
3. Screw the curved tube into the petcock with the pipe extension underneath. Pump up the air pressure in the upper chamber to a little beyond the trial initial pressure line. Allow a few seconds for the compressed air to cool to normal temperature, and then bring the gauge needle to the selected initial pressure line by pumping or bleeding off air and tapping the gauge lightly with your fingers. Close both petcocks.

4. Press the main air valve thumb lever to release the air into the measuring bowl. While keeping the thumb lever depressed, tap the gauge lightly with your fingers. The gauge should read 0.0% ± 0.1%.

5. Position the calibrated vessel under the curved tube. Open the petcock with the curved tube attached, and control the water flow by pressing the thumb lever and adjusting the petcock position. Fill the 5% calibration vessel full of water. Close the petcock.

6. Release the remaining compressed air from the free petcock. Open the other petcock and let the water in the curved tube run back into the base. There is now a 5% air void in the base.
7. With both petcocks open, pump up the air pressure to a little beyond the trial initial pressure line. Allow a few seconds for the compressed air to cool to normal temperature, and then bring the gauge needle to the selected initial pressure line by pumping up or by bleeding off air and tapping the gauge lightly with your fingers.

8. Close both petcocks, and press the main air valve thumb lever to release the air into the base container. While keeping the thumb lever depressed, tap the gauge lightly with the fingers. The gauge should read 5.0% ± 0.1%.

9. If the gauge does not register within the desired range, release the air pressure from the free petcock, open the other petcock with the curved tube, select another initial pressure line and repeat Steps 7 and 8.

   When the gauge reads correctly, withdraw additional water in the same manner as before and check the results at 10%.

10. If the gauge does not register within ± 0.2% at 10%, remove the glass from the pressure gauge and set the gauge needle to 10% as per manufacturer’s recommendations, or replace the gauge if necessary. When changes are made to the gauge, repeat Steps 1 thru 10.

11. When the correct initial line has been determined and the meter properly calibrated, attach a tag to the meter cover with the date of calibration, proper initial line, and name of person who calibrated the meter.
SECTION- F
AIR CONTENT TEST PROCEDURE - VOLUMETRIC METHOD
ASTM C173/C173M

I. SCOPE

This test method describes the procedure for determining the air content of freshly mixed portland cement concrete containing any type of aggregate, whether dense or lightweight, by the volumetric method.

II. GENERAL

In this test, water and isopropyl alcohol are used to displace air in the concrete and the resulting drop in water level is observed to determine the air content. This test measures the air contained in the mortar portion of the concrete and is not affected by the air that may be present inside the porous aggregate particles.

Therefore, this is the appropriate test method to determine the air content of portland cement concrete containing highly porous coarse aggregates, such as lightweight expanded shale or air cooled slag.

This test method requires adding isopropyl alcohol when the meter is initially filled with water. This insures that little or no foam will be present in the top section of the meter neck after the first and subsequent rolling and rocking of the air meter. If foam appears in the neck and is greater than the equivalent of 2% air above the water level, the test is invalid and must be repeated using a larger quantity of alcohol. The addition of alcohol to dispel foam after the initial filling of the meter is not permitted.

III. EQUIPMENT

1. Base Container - a rigid cylindrical container suitable to withstand rough field use. The container material must not be affected by high pH cement paste, deform when stored at high temperatures or crack at low temperatures. The base container must be flanged so that it may be clamped to the top section for a watertight fit, have a diameter equal to 1 to 1.25 times the height, and a capacity not less than 0.075 ft³.

2. Top Section - with a capacity at least 20% larger than the base and equipped with a flexible gasket and a device to attach the top section to the base to form a watertight seal. The top section must also include a neck with a transparent scale that is graduated in increments not greater than 0.5%, so the percent of air can be read directly, from 0 at the top to 9% or more at the bottom. The top of the neck must also be equipped with a watertight cap that maintains a watertight seal when the meter is inverted and rolled.
3. Funnel - a special funnel that enters the top of the neck and extends to just above the top of the base container. Its discharge end must be baffled so that minimum disturbance of the concrete occurs when the water is introduced.

4. Tamping Rod - a round, straight steel rod ¾ in. ± 1/16 in diameter. The length shall be at least 4 in. ± ¼ in. greater than the depth of the mold, but not greater than 24 ± ¼ in., with the tamping or both ends rounded to a hemispherical tip. Made of steel, high density polyethylene, or other highly abrasion resistant plastic.

5. Strike-off bar - a flat, straight steel bar at least ⅛ in. x ¾ in. x 12 in. or a flat straight bar at least ⅛ in. x ¾ in. x 12 in. made of high density polyethylene or other highly abrasion resistant plastic.

6. Calibrated Cup - a metal or plastic cup having the capacity or being graduated in increments equal to 1.00 ± 0.04% of the base container volume. Only use the calibrated cup to add water when the concrete air content exceeds the graduated scale of the meter.

7. Measuring Vessel for Isopropyl Alcohol - with a minimum capacity of 500 mL (1 pt.) and graduations not larger than 100 mL (4 oz.).

8. Syringe - a small rubber bulb having a minimum capacity of 50 mL (2 oz.).

9. Pouring Vessel for Water - a vessel having a minimum capacity of 1 L (1 qt.).

10. Isopropyl Alcohol - 70% by volume (approximately 65% by weight), commonly known as rubbing alcohol. See Table F-1 for correction factors for Air Meter Readings.

11. Scoop - a small metal scoop of appropriate size used to fill the base container.

12. Mallet - with a rubber or rawhide head and weighing 1.25 ± 0.50 lb.

IV. CALIBRATION

Perform the calibration as outlined in ASTM Designation C173/C173M. The Materials Bureau in Albany will initially check the equipment before it is issued to the Region. Since the equipment has no moving parts that wear or need periodic adjustment, future calibration should occur yearly or whenever there is a reason to suspect damage or deformation of the meter or the calibrated cup.

V. SAMPLING

Sample the concrete in accordance with “SECTION-A, CONCRETE SAMPLING PROCEDURES”.

30
VI. TEST PROCEDURE

1. Dampen the base with a damp cloth or sponge. Fill the base in two equal layers, rodding each layer 25 times with the tamping rod and rap around the side of the bowl 10 to 15 times with the mallet to close voids left by the rod. Rod the first layer full depth without forcibly striking the bottom. Slightly overfill the container when filling the top layer. When rodding the top layer, allow the rod to penetrate the previous layer approximately 1 in. Distribute the strokes uniformly over the entire section of the cross section of the base.

2. Remove the excess concrete by sliding the strike-off bar across the top with a sawing motion. Perform the finishing with the minimum work necessary to produce a flat even surface level with the rim.

3. Wipe the flange clean, dampen the inside of the top section with a damp cloth or sponge, and clamp the top section to the base container. Insert the special funnel and add at least 500 mL/1 pint of water and the required amount of isopropyl alcohol (see Table F-1). Record the amount of alcohol added. Continue adding water until it rises in the neck to slightly below the zero mark.
**TABLE F-1**

**CORRECTION FACTORS FOR ISOPROPYL ALCOHOL**

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<th>Liters/Pints *</th>
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</tbody>
</table>

* The amount of alcohol necessary to obtain a stable reading and a minimum amount of foam at the top of the water column depends upon a number of factors. Concrete mixes with high cement contents (typically all DOT mixes) and air contents greater than 6% may require more than 1.5L/3.0 pints of alcohol. Generally, the amount of alcohol used for a given concrete mix design should not change during the course of the job.

** Subtract from meter reading and then record to the nearest 0.25%

† Note: When using 2.5 L/5.0 pints of alcohol, limit the amount of water initially added to avoid overfilling the meter (typical DOT meter holds approximately 2650 mL). However, add at least 100 mL of water initially to limit the contact of the concentrated alcohol with the top surface of the concrete.

4. Remove the funnel and add water with the syringe until the bottom of the meniscus is level with the zero mark. Attach and tighten the watertight cap.
5. Invert and agitate the air meter horizontally for a minimum of 45 seconds to free the concrete from the base. To keep aggregate from lodging in the neck, do not invert the air meter for more than 5 seconds at a time.

This procedure frees the concrete from the base. When the concrete breaks free, the aggregate can be heard moving in the air meter.

6. After completing the inverting and agitating procedure, tilt the air meter and vigorously roll and rock the unit for approximately 1 minute, keeping the neck elevated at approximately 45° from the vertical position at all times. If liquid is found to be leaking from the meter during the inversion and rolling procedures, the test is invalid and a new test must be run using a new representative sample.

7. Set the air meter upright. Loosen the cap to allow any pressure to escape and wait for the liquid level to stabilize.

The liquid level is considered stable when it does not change more than 0.25% within a 2 minute period.
If there is more than 2% foam on top of the liquid level or if it takes more than 6 minutes for the liquid level to stabilize, the test is invalid. Run a new test with a new representative sample and use a larger addition of alcohol than previously used.

After the initial reading is obtained, re-tighten the cap and repeat Steps 6 and 7. When the liquid level stabilizes and the first and second readings do not vary more than 0.25%, read the level, apply the required correction, if needed (see Table F-1), and record the final percent air to the nearest 0.25%.

If the first and second readings vary by more than 0.25%, record the second reading as the initial reading and repeat Steps 6 and 7. When the liquid level stabilizes and the readings do not vary more than 0.25% air, read the level, apply the required correction, if needed (see Table F-1), and record the final percent air to the nearest 0.25%.

If the third meter reading changes by more than 0.25%, discard the test and run a new test with a new representative sample and use a larger addition of alcohol than previously used.

8. If the air content is greater than the calibrated range of the meter, add a sufficient number of calibrated cups of water to bring the liquid level within the calibrated range (1 cup equals 1% air). Record the number of cups of water used and add to the final meter reading along with the required correction, if needed, (see Table F-1), and record the final percent air to the nearest 0.25%.

9. Disassemble the air meter and examine the contents in the base. If portions of undisturbed concrete are found, the test is invalid. Retest using another sample from another portion of the original composite sample.

- CLEAN YOUR EQUIPMENT-
SUMMARY

AIR CONTENT PROCEDURE - VOLUMETRIC METHOD

1. Re-mix the composite sample.
2. Dampen inside of the base with a damp cloth or sponge.
3. Fill the base in 2 equal layers.
4. Rod each layer 25 times, distributing the strokes uniformly over the cross section of each layer. Rod the first layer full depth. Rod the top layer to penetrate the underlying layer approximately 1 in.
5. Rap around the side of the base 10-15 times with the mallet after rodding each layer to close voids left by the rod.
6. Strike off the excess concrete until flush with the top of the container using the strike-off bar. Wipe the flange clean.
7. Clamp the top section to the base. Insert the funnel, and add at least 500 mL/1 pint of water and the required amount of isopropyl alcohol (see Table F-1). Record the amount of alcohol added. Continue adding water until it rises in the neck to slightly below the zero mark.
8. Remove funnel and use the rubber syringe, filled with water, to adjust the water level until the bottom of the meniscus is level with the zero mark.
9. Attach and tighten the water tight cap.
10. Invert and agitate the air meter horizontally repeatedly for a minimum of 45 seconds to free all the concrete from the base. Do not invert for more than 5 seconds at a time.
11. Roll and rock the air meter for approximately 1 minute with the neck elevated approximately 45°.
12. Stand the meter upright. Loosen the cap to allow any pressure to escape and wait for the water level to stabilize. The liquid level is considered stable when it does not change more than 0.25% within a 2 minute period.
13. If there is more than 2% foam on top of the liquid level, or if it takes more than 6 minutes for the liquid level to stabilize, the test is invalid. Run a new test with a new representative sample and use a larger addition of alcohol than previously used.
14. After the initial reading is obtained, re-tighten the cap and repeat Steps 11 and 12. When the liquid level stabilizes and the first and second readings do not vary by more than 0.25%, read the level, apply the required correction, if needed (see Table F-1), and record the final percent air to the nearest 0.25%.
15. If the first and second readings vary by more than 0.25%, record the second reading as the initial reading and repeat Steps 11 and 12. When the liquid level stabilizes and the second and third readings do not vary more than 0.25% air, read the level, apply the required correction, if needed (see Table F-1), and record the final percent air to the nearest 0.25%.

16. If the third meter reading changes by more than 0.25%, discard the test and run a new test with a new representative sample and use a larger addition of alcohol than previously used.

17. If the air content is greater than the calibrated range of the meter, add a sufficient number of calibrated cups of water to bring the liquid level within the calibrated range (1 cup equals 1% air). Record the number of cups of water used, and add to the final meter reading along with the required correction, if needed, (see Table F-1) and record the final percent air to the nearest 0.25%.

18. Disassemble the air meter and examine the contents in the base. If portions of undisturbed concrete are found, the test is invalid.
SECTION- G  
UNIT WEIGHT AND YIELD TEST PROCEDURE  
ASTM C138/C138M  

I. SCOPE

This test method describes the procedure for determining the weight per cubic foot yield, and relative yield of freshly mixed portland cement concrete.

II. GENERAL

There is no required testing frequency for unit weight or yield, but it should be determined at the beginning of concrete production and periodically thereafter to see if the yield requirements of the mix design are being met.

Determine the air content by the “PRESSURE METHOD” (SECTION- D) or by the “VOLUMETRIC METHOD” (SECTION- F) if lightweight or porous coarse aggregates are used.

III. SAMPLE

Re-mix the composite concrete sample in accordance with “SECTION- A, CONCRETE SAMPLING PROCEDURES.”

IV. EQUIPMENT

1. Container - a cylindrical metal container, preferably with handles, watertight, with the top and bottom true and even, sufficiently rigid to retain its shape under rough usage, with the height approximately equal to the diameter (height not less than 80% or more than 150% of the diameter) and a capacity conforming to C29/C29M for the aggregate size to be tested. For Department use, the base container of the pressure air meter is suitable, with a known volume of about 0.25 ft³.

2. Balance (scale) - accurate to within 0.3% of the test load at any point within the range of use, and with minimum graduations of 0.10 lb.

3. Miscellaneous Equipment
   - Scoop - a small metal scoop of appropriate size used to fill the base container.
   - Tamping Rod - a round, straight steel rod % in. ± 1/16 in. in diameter. The length shall be at least 4 in. ± ⅛ in. greater than the depth of the mold, but not greater than 24 ± ⅛ in., with the tamping or both ends rounded to a hemispherical tip.
   - Mallet - with a rubber or rawhide head, weighing 1.25 ± 0.50 lb. for use with containers having a volume of 0.5 ft³ or less, and one weighing 2.25 ± 0.50 lb. for use with containers having a volume larger than 0.5 ft³.
• Strike-Off Plate - a flat rectangular rigid plate, at least 2 in. greater in width than the diameter of the base, with straight and smooth edges within a tolerance of 1/16 in. Typically the Department uses an acrylic plastic plate with a minimum thickness of ½ in.

V. TEST PROCEDURE

1. Re-mix the composite sample.

2. Dampen the inside of the container and determine the tare (empty) weight.

3. Fill the container with concrete in the same manner prescribed for the pressure air meter (SECTION- D); i.e. 3 layers of equal depth, rodding each layer 25 times with the tamping rod and rapping the sides of the container smartly with the mallet 10 to 15 times to close the voids making sure that the top layer is slightly overfilled.

4. Strike off the concrete to a smooth surface using the strike-off plate. Press the strike-off plate on to the top surface of the container covering about ⅔ of the surface, and withdraw the plate with a sawing motion to finish the area originally covered. Next, place the plate on the top of the container to cover the original ⅔ of the surface and advance it while maintaining a downward pressure and a sawing motion to cover the entire surface of the container. Use several final strokes with the inclined edge of the plate to produce a smooth finished surface.

5. Clean the outside of the container of any adhering concrete or mortar.

6. Weigh the concrete filled container to the nearest 0.10 lb.

7. Calculate the unit weight.

- CLEAN YOUR EQUIPMENT -
VI. COMPUTATIONS

A. Unit Weight (Density)

Calculate the net weight of the concrete in pounds by subtracting the weight of the dampened empty container from the gross weight. Calculate the unit weight by dividing the net weight by the volume of the container used.

\[
D = \frac{W_1 - W_T}{V}
\]

Where:  
\(D\) = Unit Weight (Density) - (lbs./ft.\(^3\))  
\(W_1\) = Gross weight - weight of container filled with concrete - (lbs.).  
\(W_T\) = Weight of dampened empty container - (lbs.).  
\(V\) = Volume of container - (ft.\(^3\)).

B. Yield

Determine the volume of concrete (yield) produced as follows:

\[
S = \frac{W_C + W_S + W_A + W_W}{D \times 27}
\]

Where:  
\(W_C\) = Recorded batch weight of cement - (lbs.).  
\(W_S\) = Recorded batch weight of sand - (lbs.)  
\(W_A\) = Recorded batch weight of coarse aggregate – (lbs.)  
\(W_W\) = Total weight of mixing water added to batch – (lbs.)  
(1 gallon = 8.345 lbs.)  
\(S\) = Actual volume of concrete produced - (cubic yards).  
\(D\) = Measured unit weight of concrete – (pounds per cubic foot.)
C. Relative Yield

Relative yield is the ratio of “actual volume” to the “designed volume” of concrete produced for the batch. Calculate the relative yield as follows:

\[ Y = \frac{S}{V_d} \quad (100) \]

Where:  
\[ Y \quad = \quad \text{Relative yield expressed in percent.} \]
\[ S \quad = \quad \text{Actual volume (yield) of concrete produced in cubic yards.} \]
\[ V_d \quad = \quad \text{Volume of concrete which the batch was designed to produce in cubic yards.} \]

A fluctuation of ± 2% in relative yield is considered normal. If a greater fluctuation occurs, conduct a retest and determine the reason for the fluctuation.
SECTION- H
CONCRETE CYLINDER FABRICATION PROCEDURE
ASTM C31/C31M

I. SCope
This test method describes the procedure for making and curing compressive strength test cylinders.

II. General
Concrete test cylinders are made to determine the compressive strength properties of the mix. Plastic portland cement concrete is placed in molds in a prescribed manner and the cylinders are cast in pairs.

The compressive strength test consists of measuring the maximum load carried by a cylinder before failure occurs. Strength is calculated by dividing the failure load by the cross-sectional area of the cylinder. This test is normally performed when the cylinders are 28 days old, but may be conducted at any time, as requested by the Engineer.

III. Sample
Sample the concrete for test specimens in accordance with ASTM C172/C172M and “SECTION- A, CONCRETE SAMPLING PROCEDURES.”

IV. Equipment
1. Molds - cylindrical in shape, watertight during use, conforming to ASTM C470/C470M. However, the diameter of the cylinder must be at least three times the nominal maximum size of the coarse aggregate in the concrete mix.

2. Tamping Rod* - a round straight steel rod, with the tamping end or both ends rounded to a hemispherical tip.
   - 6 in. x 12 in. cylinders - use a 5/8 ± 1/16 in diameter rod.
   - 4 in. x 8 in. cylinders - use a 3/4 ± 1/16 in diameter rod.
   * The length shall be at least 4 ± ¼ in. greater than the depth of the mold, but not to exceed 24 ± ⅛ inches.

3. Scoop - a small metal scoop of appropriate size used to fill the cylinder mold so that concrete is not excessively spilled during placement into the mold.

4. Mallet (optional) - with a rubber or rawhide head and weighing 1.25 ± 0.50 lb.

5. Screed bar or trowel (optional) - used to finish the top of the cylinder to produce a flat even surface.

6. Cylinder Caps – Plastic domed caps from the same manufacturer as the cylinder molds.

7. Concrete Cylinder Curing Box - meeting Department Specifications or as determined by the Engineer.
V. TEST PROCEDURE

1. Sample the concrete in accordance with SECTION-A. Perform the slump test in accordance with SECTION C and an air test in accordance with SECTIONS D or F.

2. Identify each cylinder with an indelible marking pen, or other suitable means not affected by water or moisture. Place the cylinder molds on a level, smooth, rigid surface, free of vibrations and other disturbances. Make the specimens as near as practical to where they are to be stored.

3. Fill the molds in rotation, placing a scoopful of concrete first in one and then in the other, until each mold is ¾ full for 6 in. x 12 in. cylinders (½ full for 4 in. x 8 in. cylinders). In placing each scoopful, move the scoop around the top edge of the mold to insure symmetrical distribution of the concrete within the mold.

4. Using the required size rod, rod the bottom layer throughout its depth 25 times without forcibly striking the bottom of the mold. Distribute the strokes evenly over the entire cross-section of the mold. After rodding, tap around the sides of the mold lightly with the mallet or open hand 10 to 15 times to close voids left by the rod.

5. Fill the molds in the same manner as Step 3 until each mold is ¾ full for 6 in. x 12 in. cylinders (full for 4 in. x 8 in. cylinders). Rod the second and top layer with 25 strokes, penetrating into the layer below approximately 1 in. Tap around the sides 10 to 15 times with the mallet or open hand to close voids left by the rod.
6. Fill the molds to overflowing when placing the top layer and rod 25 times in the prescribed manner, adding more concrete if necessary. After rodding, tap around the sides 10 to 15 times with the mallet or open hand to close voids left by the rod.

7. Strike off excess concrete using the tamping rod or other suitable tool to obtain a smooth surface. Perform all finishing with the minimum manipulation necessary to produce a flat surface level with the top of the mold.

8. Immediately after finishing, move the cylinders to a safe place for initial curing. When using single use molds, lift and support the cylinder from the bottom. If the top surface is marred during moving, immediately refinish.

9. Cover the cylinders immediately with the plastic covers supplied with the cylinder mold or plastic cylinder bags. Clean off any excess concrete from the sides of the mold and verify that they were properly labeled. Allow to cure for a minimum of 24 hours at a temperature range of 60° F to 80° F (see next page, Curing Cylinders, for more details).
VI. CURING CYLINDERS

1. **Control Series**: Leave the cylinders at or near their casting positions on a rigid level surface free from vibrations or in an approved curing box for a minimum of 24 hours. Provide adequate protection so that the specimens are not subjected to temperatures outside the range of 60°F to 80°F, and in an environment preventing moisture loss during the initial cure period.

2. **Other**: If the test cylinders are being used to determine an “early open sequence,” or “in-place” strength, cure them the same as the concrete placement they represent, or as directed by the Engineer.

**NOTE**: If the cylinders are not transported within 48 hours, remove the molds, re-label the cylinder with a permanent marker and place the cylinders in a water filled curing box operating at a temperature of 73.5°F ± 3.5°F. Leave the cylinders in the curing box undisturbed until time of transporting or testing.

VII. CONCRETE CYLINDER REPORT

For each pair of cylinders cast, documentation must be entered into the Department’s AASHTO SiteManager/LIMS database, see *SECTION- VII. DOCUMENTATION*. 
1. Re-mix the composite sample.
2. Label the cylinders using a permanent marker and place the molds on a level, smooth, rigid surface, free of vibrations.
3. Fill the molds in rotation, placing a scoopful of concrete in one and then in the other. Move the scoop around the top edge of the mold to insure symmetrical distribution within the mold.
4. Fill the mold in 3 equal layers for 6 in. x 12 in. cylinders (2 equal layers for 4 in. x 8 in. cylinders).
5. Rod each layer 25 times using the rounded end of the appropriate size rod, distributing the strokes uniformly over the cross section of each layer.
6. Rod the bottom layer throughout its depth without forcibly striking the bottom.
7. Rod the middle and top layer to a depth of approximately 1 in. into the underlying layer.
8. Tap around the sides of the mold 10-15 times preferably with open hand, or the mallet after rodig each layer to close voids left by the rod.
9. Strike off the concrete flush with the top of the mold using the tamping rod or other suitable tool with a minimum amount of manipulation necessary to produce a flat even surface.
10. Immediately after finishing, move to a safe location for initial curing.
11. If the top surface is marred during moving, refinish using minimum amount of manipulation necessary to produce a flat, even surface. Cover the test cylinder with plastic caps supplied with the cylinder mold or with plastic cylinder bags. Clean off any excess concrete from the sides of the mold and verify that they were properly labeled and allow to cure for a minimum of 24 hours. Provide adequate protection so that the specimens are not subjected to temperatures outside the range of 60°F to 80°F.
12. If the cylinders are not transported within 48 hours, remove the molds, re-label the cylinder with a permanent marker and place the cylinders in a water filled curing box operating at a temperature of 73.5°F ± 3.5°F. Leave the cylinders in the curing box undisturbed until time of transporting or testing.
SECTION I
UNIFORMITY TEST PROCEDURE
(Abbreviated - Slump and Air Only)

I. SCOPE

This section describes an abbreviated procedure for determining concrete uniformity. The uniformity test is also known as a mixer efficiency test, and it is used only when required by the Specifications or as directed by the Engineer. See Materials Method 9.1 for the complete test procedure.

II. GENERAL

This test is used to determine the ability of a mixer, conveyance system or hauling unit, to mix or deliver uniform concrete. Samples of plastic concrete are taken from points near the beginning and near the end of discharge from a mixer. The results of the slump and air content tests on the “front” and “back” samples are compared, and if the concrete is uniform, the results will be similar and within the prescribed limits.

III. EQUIPMENT

1. Sample and Water Containers
2. Two Slump Cones and Accessories
3. Two Air Meters and Accessories

IV. SAMPLE

Take individual samples after discharge of approximately 15% and 85% of the load. Due to the difficulty of determining the actual quantity of concrete discharged, the intent is to provide two samples that represent widely separated portions, but not the beginning and end of the load.

Obtain the samples directly from the discharge of mixers and hauling equipment prior to any subsequent transportation, spreading or vibration operations.

V. TEST PROCEDURE

Conduct slump tests in accordance with SECTION-C. Conduct air content tests in accordance with SECTIONS- D or F

VI. DATA SUMMARY AND CRITERIA

Upon completion of testing, summarize the data and compare to the “uniformity criteria” as shown in NYSDOT Specifications Section 501 and MM 9.1.
SELF–CONSOLIDATING CONCRETE

I. SCOPE
This section describes test procedures to be utilized for testing self-consolidating portland cement concrete (SCC).

II. GENERAL
Self-consolidating concrete may also be known as self-compacting concrete. This type of concrete was designed to be able to flow and consolidate under its own weight. At the same time it is cohesive enough to fill spaces of almost any shape or size without use of vibration, and without segregation or bleeding. Because of the material flow characteristics, conventional concrete testing techniques have been either modified or replaced to obtain defined test results. At the time of this printing, ASTM has not approved specific SCC test methods pertaining to air content tests and casting compression test cylinders.

III. TEST PROCEDURES

- **CONCRETE SAMPLING PROCEDURES:** Follow same procedure as conventional PCC, (see SECTION –A).
- **TEMPERATURE:** Follow same procedure as conventional PCC, (see SECTION- B).
- **SLUMP TEST:** Has been replaced with “Slump Flow” test, follow SECTION- J.
- **AIR CONTENT TEST:** Follow same procedure as conventional PCC (see SECTION- D), with the following modifications:
  - Fill the base container in one lift without rodding.
  - Tap the sides of the container using the mallet to remove any entrapped air, if deemed necessary.
- **UNIT WEIGHT AND YIELD TEST:** Follow same procedure as conventional PCC (see SECTION -G), with the following modifications:
  - Fill the base container in one lift without rodding.
  - Tap the sides of the container using the mallet to remove any entrapped air, if deemed necessary.
- **CONCRETE CYLINDER FABRICATION:** Follow same procedure as conventional PCC (see SECTION- H), with the following modifications:
  - Fill the test cylinder mold in one lift without rodding.
  - Tap the sides of the mold using open hand or the mallet to remove any entrapped air, if deemed necessary.
I. SCOPE

This test method describes the procedure for determining the slump flow of self-consolidating portland cement concrete (SCC).

II. GENERAL

The slump flow test is used to monitor the consistency and possible aggregate segregation of plastic SCC. It is an indirect measure of the amount of water within a mix (water/cement ratio). However, with the admixtures being used to produce flowable concrete without segregation, this test is not a good indicator for “measuring” water/cement ratios.

Typically, with strict control of all concrete materials, increases in water content will lower strength, durability, and cause the mix to segregate.

A sample of freshly mixed concrete is placed in a mold shaped as a frustum of a cone, meeting the requirements of ASTM C143 in a prescribed manner. The cone is then removed and the concrete allowed to flow/spread. Then, the diameter is measured in two directions, approximately 90° from each other, after the sample ceases to flow. The average of these two measurements is reported as the slump flow of the concrete.

The stability index of self-consolidating concrete can be observed visually by examining the concrete mass after performing the slump flow test and can be utilized for quality control of SCC mixes. See table J-1 for Visual Stability Index (VSI) values with corresponding criteria to assess the stability of the plastic SCC.

This test method is considered applicable for self-consolidating plastic concrete having coarse aggregate up to 25 mm (1 in.) in size. If the coarse aggregate is larger than 25 mm (1 in.) in size, segregation may occur, producing unacceptable concrete.

III. SAMPLE

Obtain a representative sample in accordance with “SECTION-A, CONCRETE SAMPLING PROCEDURES.”
IV. EQUIPMENT

1. A moist, non-absorbent, firmly supported level surface having a minimum diameter of 36 inches.

2. Mold - a standard slump cone as defined in ASTM C143/C143M, with a base diameter of 8 inches, a top diameter of 4 inches, and a height of 12 inches.

3. Container - a small container/bucket of appropriate size used to fill the mold so that concrete is not excessively spilled during placement into the mold.

4. Strike-off bar - a flat, straight steel bar at least 1\(\frac{1}{2}\) in. x \(\frac{3}{4}\) in. x 12 in. or a flat straight bar at least \(\frac{1}{4}\) in. x \(\frac{3}{4}\) in. x 12 in. made of high density polyethylene or other highly abrasion resistant plastic.

5. Measuring Device – a ruler, metal roll-up measuring tape, or rigid or semi-rigid measuring instrument marked in increments of \(\frac{1}{4}\)” or less.

V. TEST PROCEDURE

1. Dampen the inside of the container, the strike-off bar, and inside of slump cone with a damp cloth or sponge.

2. Place slump cone on a firmly supported, level, non-absorbent, moist surface that is free from vibrations, and at least 36 inches in diameter.

3. The slump cone may be filled by following either procedure “A” or procedure “B”, listed below.

   A. (Mold in the upright position) Position the mold in the center of the work surface. Firmly hold the slump cone in place by standing on the foot pieces. Fill the cone by pouring the concrete directly from a container directly into the mold until it is slightly over full in one motion.

   B. (Mold in the inverted position) Position the mold in the center of the work surface. It may be necessary to support the cone to prevent movement during filling. Fill the cone by pouring the concrete directly from a container directly into the mold until it is slightly over full in one motion.

   NOTE: If the cone moves in any way, the test is considered invalid and should be performed again using another portion of the original sample.

4. Screed off the concrete level to the top surface of the cone by using the strike-off bar.

5. Remove all concrete from around the base of the mold to ensure the flow of the concrete is not restricted.

6. Remove the mold by raising it vertically 9 \(\pm 3\) inches in one fluid motion with no lateral or twisting movement in 3 \(\pm 1\) seconds.

7. Complete the entire operation without interruption from the start of filling through removal of the slump cone within an elapsed time of no more than 2½ minutes.

8. Wait for the concrete to stop flowing and then measure the largest diameter of the resulting circular spread of the concrete to the nearest \(\frac{1}{4}\) in. (including a halo, if
FIELD INSPECTION OF PORTLAND CEMENT CONCRETE

observed). Take another measurement approximately 90° to the first measurement (including a halo, if observed) to the nearest ¼ in. (See drawing below).

9. If the readings differ by more than 2 in., the test is considered invalid and shall be repeated using another portion of the original sample.

10. Determine the slump flow by taking the average of the two readings, and report to the nearest ½ in.

11. Include the Visual Stability Index Value, if required (see table below).

<table>
<thead>
<tr>
<th>Table J-1</th>
<th>Visual Stability Index Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSI Value</td>
<td>Criteria</td>
</tr>
<tr>
<td>0 = Highly Stable</td>
<td>No evidence of segregation or bleeding.</td>
</tr>
<tr>
<td>1 = Stable</td>
<td>No evidence of segregation and slight evidence of bleeding observed as a sheen on the concrete mass.</td>
</tr>
<tr>
<td>2 = Unstable</td>
<td>A slight mortar halo ≤ ½ in. and/or aggregate pile in the center of the concrete mass</td>
</tr>
<tr>
<td>3 = Highly unstable</td>
<td>Large mortar halo ≥ ½ in. and/or large aggregate pile in the center of the concrete mass</td>
</tr>
</tbody>
</table>

Example of coarse aggregate segregation and excessive bleeding, resulting in unacceptable concrete.
### CONVERSION FACTORS AND FORMULAS

<table>
<thead>
<tr>
<th>UNIT WEIGHT</th>
<th>U.S. CUSTOMARY</th>
<th>CONVERSION FACTOR</th>
<th>METRIC UNITS</th>
<th>CONVERSION FACTOR</th>
<th>U.S. CUSTOMARY</th>
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</thead>
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<td>kg/m³</td>
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<td>× 1.686</td>
<td>lb/yd³</td>
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<table>
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<tr>
<th>ADMIXTURE DOSAGE</th>
<th>U.S. CUSTOMARY</th>
<th>CONVERSION FACTOR</th>
<th>METRIC UNITS</th>
<th>CONVERSION FACTOR</th>
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<td>L/m³</td>
<td>× 0.2022</td>
<td>gal/yd³</td>
<td></td>
</tr>
</tbody>
</table>

| STRENGTH        | psi             | MPa               | × 145.0      | psi               |
| LENGTH          | inch            | mm                | × 0.039      | inch              |
|                 | foot            | m                 | × 3.281      | foot              |

| AREA             | ft²             | m²                | × 10.75      | ft²               |

| VOLUME           | yd³             | m³                | × 1.308      | yd³               |
|                 | ft³             | m³                | × 35.31      | ft³               |
|                 | gallon          | L                 | × 0.2642     | gallon            |

| MASS             | pound           | kg                | × 2.205      | pound             |

| TEMP.            | Celsius º = (ºF - 32)/1.8 | Fahrenheit º = (ºC x 1.8) + 32 |

* Cwt = 100 lbs. of cementitious material

1 pint = 473 mL
1 gallon (gal) = 3.785 liter (L)
1 cubic foot (ft³) of water = 62.4 pounds (lbs.)
1 gallon (gal.) of water = 8.345 pounds (lbs.)

Unit Weight (lb/ft³ or kg/m³) = weight ÷ volume

Water/Cement Ratio = water weight ÷ cementitious material weight