Illinois Department of Transportation

Portland Cement Concrete

Tester Course

This Page Reserved

Portland Cement Concrete Tester Course

Prepared and Published by
Illinois Department of Transportation
Bureau of Materials

Springfield, Illinois

December 31, 2017

This Page Reserved

LAKE LAND COLLEGE
INSTRUCTOR AND COURSE EVALUATION

Course: Concrete Tester Course______ **Section:** ____________ **Date:** ____________________

PURPOSE: The main emphasis at Lake Land College is teaching. In this regard, each instructor must be continuously informed of the quality of his/her teaching and the respects in which that teaching can be improved. As a student, you are in a position to judge the quality of teaching from direct experience, and in order to help maintain the quality of instruction at Lake Land, you are asked to complete this evaluation.

DIRECTIONS: **DO NOT SIGN YOUR NAME**. Your frankness and honesty are appreciated.

First, please record your general impressions and/or comments on the following:

Course ____

____

Instructor ____

For each remaining item, circle the number from the scale which seems most appropriate to you for the instructor and course that you are evaluating. You are strongly encouraged to make any comments that will clarify particular rating on the back of this form; please refer to each item you are discussing by its number.

			WEAK				**SUPERIOR**
OBJECTIVES AND APPROPRIATENESS OF THE COURSE:							
1.	**Clarity of Objectives**	The objectives of the course were clearly identified. Objectives were adequately covered.	1	2	3	4	5
2.	**Selection content**	Content was relevant and met the level of the class.	1	2	3	4	5
ORGANIZATION AND CONTENT OF LESSONS:							
3.	**Teacher preparation**	Instructor was organized and knowledgeable in subject matter and prepared for each class.	1	2	3	4	5
4.	**Organization of classes**	Classroom activities were well organized and clearly related to each other.	1	2	3	4	5
5.	**Selection of materials**	Instructional materials and resources used specific, current, and clearly related to the objectives of the course.	1	2	3	4	5
6.	**Clarity of presentation**	Content of lessons was presented so that it was understandable to the students.	1	2	3	4	5
7.	**Clarity of presentation**	Different point of view and/or methods with specific illustrations were used when appropriate.	1	2	3	4	5

OVER

LAKE LAND COLLEGE
INSTRUCTOR AND COURSE EVALUATION
(PAGE 2)

			WEAK				SUPERIOR
PERSONAL CHARACTERISTICS AND STUDENT RAPPORT:							
8.	**Vocabulary**	Instructor's vocabulary level was appropriate for the class.	1	2	3	4	5
9.	**Pupil participation and interest**	Instructor encouraged students to ask questions and actively participate in class.	1	2	3	4	5
10.	**Personal attributes**	Instructor indicated an interest and enthusiasm for teaching the subject matter.	1	2	3	4	5
11.	**Personal attributes**	Instructor was familiar with current industry practices.	1	2	3	4	5
12.	**Personal attributes**	Instructor's mannerisms were pleasing.	1	2	3	4	5
13.	**Instructor-student rapport**	Instructor indicated a willingness to help you in times of difficulty.	1	2	3	4	5
14.	**Instructor-student rapport**	Instructor was fair and impartial in dealings with you.	1	2	3	4	5
EXAMINATION:							
15.	**Exam material**	The exam correlated to the materials being covered in class.	1	2	3	4	5
SUMMARY:							
16.	Considering everything, how would you rate this instructor?		1	2	3	4	5
17.	Considering everything, how would you rate this course?		1	2	3	4	5

COMMENTS: (Please use the area below to add any additional comments regarding the class and exam.)

PREFACE

This manual has been prepared to train the student to become a Concrete Tester. The manual discusses the various tests performed on plastic portland cement concrete, for Illinois Department of Transportation (herein referred to as "IDOT" or the "Department"), Quality Control/Quality Assurance (QC/QA) projects. The manual is intended only to provide basic information to perform tests, and shall not be used to replace the Department's "Manual of Test Procedures for Materials." The Manual of Test Procedures for Materials shall have precedence when determining the correct method to perform a test. This manual is applicable for the April 1, 2016, Standard Specifications for Road and Bridge Construction (link embedded) and the Supplemental Specification and Recurring Special Provisions, Adopted: January 1, 2017 (link embedded).

Revision History and Document Control

The Portland Cement Concrete Tester Course Manual will be reviewed by the Engineer of Concrete and Soils for adequacy annually and updated as necessary to reflect the current policies and technology changes. Updates are made to the electronic file as needed and hard copies are uncontrolled. Archive versions are available to examine in the Bureau of Materials.

Revision Date	Description	Approval
December 31, 2017	Revised Title Page.	Dan Tobias
December 31, 2017	General editorial revisions made for readability throughout document.	Dan Tobias
December 31, 2017	Revised second paragraph under "Making Strength Specimens (Cylinders or Beams)" heading of Section 8.0.	Dan Tobias
December 31, 2017	Revised second paragraph in Section 11.0.	Dan Tobias

This Page Reserved

Table of Contents

***** Only the rodding procedure will be taught in this course.

DEFINITIONS

Blended Cement — A hydraulic cement which meets the requirements of AASHTO M 240 (ASTM C 595). The hydraulic cement consists of portland cement and one or more inorganic constituents.

Cement Aggregate Mixture (CAM II) — A lean (low cement and finely divided mineral) concrete mixture for stabilized subbase.

Cement Factor — The number of kilograms of cement per cubic meter (Metric). The number of pounds of cement per cubic yard (English). Cement factor is the same as cement content.

Cementitious Material — A general term used to indicate fly ash, ground granulated blast-furnace slag, microsilica, or high-reactivity metakaolin. However, the term is misleading because fly ash, microsilica, and high-reactivity metakaolin do not have cementitious characteristics. The term may be used interchangeably with Finely Divided Minerals.

Concrete — A mixture consisting of cement, water, and aggregates; as a minimum. Admixtures and finely divided minerals may be added.

Consistency — The ability of freshly mixed concrete to flow. Consistency is measured by the slump test.

Controlled Low-Strength Material (CLSM) – A self-consolidating mortar mixture, which is typically used as a backfill.

Finely Divided Mineral — A general term to indicate fly ash, ground granulated blast-furnace slag, microsilica, or high-reactivity metakaolin. The term may be used interchangeably with Cementitious Material.

Fly Ash — The finely divided residue that results from the combustion of ground or powdered coal.

Ground Granulated Blast-Furnace (GGBF) Slag — The glassy granular material formed when molten blast-furnace slag is rapidly chilled, and then finely ground.

High-Reactivity Metakaolin (HRM) – A manufactured product formed by calcining purified kaolinite, at a specific temperature range.

Hundredweight (cwt) — A measurement which is the same as 100 lbs.

Independent Sample — A field sample obtained and tested by only one party.

Microsilica — The extremely fine by-product that results from the manufacture of silicon or silicon alloys.

Mortar — The fine aggregate, cement, finely divided minerals, water, and air in a concrete mixture.

Paste — The cement, finely divided minerals, water, and air in a concrete mixture.

Pervious Concrete — A permeable concrete that allows water to infiltrate the concrete and drain into the soil beneath it. The zero slump concrete mixture has little or no fine aggregate.

Plasticity — The ease of molding the concrete. A plastic concrete mixture will maintain suspension of the aggregates.

Portland Cement — A hydraulic cement which meets the requirements of AASHTO M 85 (ASTM C 150).

Segregation — For concrete, the coarse aggregate has separated from the mortar. For aggregate, the separation of a well graded production aggregate into individual sizes, due to handling.

Self-Consolidating Concrete (SCC) — A flowable concrete mixture that does not require mechanical vibration for consolidation.

Split Sample — One of two equal portions of a field sample, where two parties each receive one portion for testing.

Standard Specifications — The Standard Specifications for Road and Bridge Construction.

Supplementary Cementitious Material — See definition for Cementitious Material.

Wash Water — Residual rinse water in the drum of a truck mixer or truck agitator.

Water/Cement Ratio — The mass (weight) of water, divided by the mass (weight) of cement. The water shall include mixing water, water in admixtures, free moisture on the aggregates, and water added at the jobsite.

When fly ash, ground granulated blast-furnace slag, microsilica, or high-reactivity metakaolin are used as part of the cement in a concrete mix, the water/cement ratio will be based on the total cementitious material contained in the mixture.

Workability — A measure of how easy or difficult it is to place, consolidate, and finish concrete.

Yield — The volume of freshly mixed concrete from a known quantity of materials.

CLASS OF CONCRETE

Class Designation	Description
PV	Pavement
PP	PCC Patching
RR	Railroad Crossing
BS	Bridge Superstructure
PC	Precast Concrete
PS	Precast Prestressed
DS	Drilled Shaft
SC	Seal Coat
SI	Structures (except superstructure)

Refer to Article 1020.04 for additional information.

1.0 QUALIFICATIONS OF CONCRETE TESTER

The qualifications of the Concrete Tester shall consist of successful completion of the Department's 1/2 day Portland Cement Concrete Tester Course.

2.0 COURSE REQUIREMENTS FOR SUCCESSFUL COMPLETION

- Prerequisite Course — None.
- Written Test — The test is open book. Time limit is 1 hour. Minimum grade of 70 is required.
- Written Retest — If the student fails the written test, a retest will not be performed. The student shall retake the class and the test.
- Notification — The student will be notified by letter of their test score, and 3 professional development hours earned will be indicated on the letter if the student receives a passing score. A certificate of completion is not issued for this course. Once trained, the Department will not require the individual to take the class again for recertification purposes.

3.0 DUTIES OF CONCRETE TESTER

The duties of the Concrete Tester as they apply to Portland Cement Concrete (PCC) mixtures, Cement Aggregate Mixture II (CAM II), and Controlled Low-Strength Material (CLSM) shall consist of the following:

- Sample the mixture.
- Perform temperature, slump, slump flow (self-consolidating concrete (SCC)), flow (CLSM), J-Ring (SCC), L-Box (SCC), hardened visual stability index (SCC), dynamic segregation index (SCC), air content and unit weight tests.
- Make strength and static segregation (SCC) specimens.
- Monitor truck revolutions and haul time.
- Observe the mixture and notify the Level I or Level II PCC Technician of any problems.
- Assist the Level I or Level II PCC Technician with adjustments to a mixture, by adding water or an admixture. (Note to IDOT Personnel: Contractor personnel are responsible for the amount of water or admixture added.)
- For a mixture which is not mixed on the jobsite, ensure the required information is recorded on the delivery ticket.
- Document all observations, inspections, adjustments to the mix design, test results, retest results, and corrective actions promptly, and in the specified format.
- Report truck revolutions, haul time, and test results to the Level I or Level II PCC Technician. Immediate notification is required if truck revolutions, haul time, or test results are near specification limits or unsatisfactory.

In addition to the above duties, the Concrete Tester is advised to take safety precautions when testing concrete. Safety glasses should be worn because mortar from the concrete can splash in your eyes. In addition, gloves should be worn to protect your hands from the cement which has a high pH that can irritate the skin.

4.0 SUPERVISION OF CONCRETE TESTER

The Concrete Tester shall be monitored on a daily basis by the Level I or the Level II PCC Technician when performing tests.

When a Concrete Tester is at the jobsite, a Level I PCC Technician may be required at a different location because of multiple pours. In this case, the Concrete Tester shall be able to contact the Level I PCC Technician by cellular phone, two-way radio or other methods approved by the Engineer.

5.0 BATCH PLANTS

There are two types of batch plants, which are defined as follows:

- Dry Batch Plant - The concrete ingredients are measured by the plant and charged into a truck mixer for mixing. This operation is called **truck-mixed** or sometimes **transit-mixed** concrete.

- Wet Batch Plant - The concrete ingredients are measured and mixed by the plant, and discharged into a delivery unit. This operation is called **stationary-mixed** or **central-mixed** concrete.

A concrete batch is defined as the materials used for one mixing operation. Two batches may be needed to fill a mixer, if the largest batch that can be weighed by the plant is smaller than the amount that can be mixed. Article 1103.02(b) permits a maximum of three weighings for charging a mixer.

6.0 TRUCK REVOLUTIONS

Since stationary-mixed (central-mixed) concrete is completely mixed in a stationary mixer, the number of truck revolutions **is not recorded** upon arrival at the jobsite. The concrete is delivered in a truck agitator, a truck mixer operating at agitating speed, or a nonagitator truck.

Since truck-mixed (transit-mixed) concrete is completely mixed in a truck mixer for delivery, the number of truck revolutions **is recorded** upon arrival at the jobsite.

Since shrink-mixed concrete is mixed partially in a stationary mixer and completed in a truck mixer for delivery, the number of truck revolutions **is recorded** upon arrival at the jobsite.

The truck revolutions or a broken truck revolution counter are to be reported to the Level I PCC Technician. A batch of concrete delivered by a truck with a broken revolution counter shall be rejected by the PCC Level I Technician.

If additional water or an admixture is added at the jobsite, the concrete batch shall be mixed a minimum of 40 additional revolutions after each addition according to Articles 1020.11(a)(2) and 1020.11(a)(3).

Notify The PCC Level I Technician if the total number of revolutions exceeds 300. The concrete mixture is acceptable to place, but a slower agitating speed may be warranted.

The recording of final truck revolutions is optional.

7.0 HAUL TIME

Haul time shall end when the truck is emptied for incorporation of the concrete into the work according to Article 1020.11(a)(7).

- NONAGITATOR TRUCKS

  The maximum haul time for nonagitating trucks is 30 minutes according to Article 1020.11(a)(7).

- MIXER AND AGITATOR TRUCKS

  The maximum haul time for truck mixers and truck agitators according to Article 1020.11(a)(7) is as follows:

Concrete Temperature at Point of Discharge, °F (°C)	**Haul Time Hours**	**Minutes**	
50 - 64 (10 - 17.5)	1	30	
> 64 (> 17.5)	1	0	(without retarder)
> 64 (> 17.5)	1	30	(with retarder)

  When installing chain link fence or woven wire fence, the time limit for unloading may be extended to 120 minutes when approved by the Engineer according to Article 664.02 Note 2. The concrete shall be mixed in truck mixers or transported in agitating trucks.

- PLANT TESTING

  To encourage start-up testing for mix adjustments at the plant, the first two trucks are allowed an additional 15 minutes haul time whenever such testing is performed according to Article 1020.11(a)(7).

  The Concrete Tester should be aware the extra time may cause the concrete mixture to be a little drier, when it finally arrives at the jobsite.

- QUALITY CONTROL

  If the haul time approaches or exceeds the specification limits, the Concrete Tester shall immediately notify the Level I PCC Technician. A batch of concrete not within the haul time specification limits at the jobsite, shall be rejected by the Level I PCC Technician.

8.0 EQUIPMENT NEEDED FOR SAMPLING AND TESTING OF CONCRETE

The Manual of Test Procedures for Materials shall be referred to for more detailed equipment information.

AT THE PLANT OR LOCATION APPROVED BY THE ENGINEER:

Proportioning PCC, CAM II, CLSM

Aggregate Moisture Test Equipment, and Balance or Scale

Sampling Plastic PCC, CAM II, CLSM

Wheelbarrow or Similar Equipment

Shovel

Testing Plastic PCC, CAM II, CLSM

Slump Kit (PCC or CAM II)

Plastic Cylinder for Flow Test (CLSM)

Air Meter Kit and Calibration Equipment

Unit Weight Kit, Calibration Equipment, and Balance or Scale

Thermometer

Ruler

Hand Scoop or Trowel

Vibrator (If Required)

Slump Flow Kit (Required only for self-consolidating concrete.)

J-Ring or L-Box Kit (Required only for self-consolidating concrete.)

AT THE JOBSITE:

Sampling Plastic PCC, CAM II, CLSM

Wheelbarrow or Similar Equipment

Shovel

AT THE JOBSITE:

<u>Testing Plastic PCC, CAM II, CLSM</u>

Slump Kit (PCC or CAM II)

Plastic Cylinder for Flow Test (CLSM)

Air Meter Kit and Calibration Equipment

Thermometer

Ruler

Hand Scoop or Trowel

Vibrator (If Required)

Slump Flow Kit (Required only for self-consolidating concrete.)

J-Ring or L-Box Kit (Required only for self-consolidating concrete.)

<u>Making Strength Specimens (Cylinders or Beams)</u>

Plastic Cylinder Molds,
6 x 12 in. (150 x 300 mm) or 4 x 8 in. (100 x 200 mm)

Plastic Cylinder Lids, 6 in. (150 mm), 4 in. (100 mm) or
other material per Illinois Modified AASHTO T 23

OR

Steel or Plastic Beam Molds (typical length)
6 in. x 6 in. x 18 in. (152 mm x 152 mm x 457 mm), or
6 in. x 6 in. x 19 in. (152 mm x 152 mm x 483 mm), or
6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm), or
6 in. x 6 in. x 21 in. (152 mm x 152 mm x 533 mm), or
6 in. x 6 in. x 30 in. (152 mm x 152 mm x 762 mm)

Plastic Cover with Absorbent Pad, or
other material per Illinois Modified AASHTO T 23

AND

Tamping Rod or Vibrator (as appropriate)

Mallet

Hand Scoop (Optional)

Trowel or Wood Float

9.0 DELIVERY TRUCK TICKET

For a mixture which is not mixed on the jobsite, a delivery ticket for each load of concrete, cement aggregate mixture II, or controlled low strength material is required.

The following information shall be recorded on each delivery ticket: (1) ticket number; (2) name of producer and plant location; (3) contract number; (4) name of Contractor; (5) stamped date and time batched; (6) truck number; (7) quantity batched; (8) amount of admixture(s) in the batch; (9) amount of water in batch; and (10) Department mix design number.

The following information shall be recorded on each delivery ticket or in a bound hardback field book: initial revolution counter reading (final reading optional) at the jobsite, if the mixture is truck-mixed; time discharged at the jobsite; total amount of each admixture added at the jobsite; and total amount of water added at the jobsite.

The Level I PCC Technician will provide the documentation format to be used by the Concrete Tester, for recording information at the jobsite.

10.0 ILLINOIS MODIFIED AASHTO R 60 — SAMPLING FRESHLY MIXED CONCRETE

Note: AASHTO R 60 is formerly AASHTO T 141.

Obtain the concrete sample at or near the point of discharge by the delivery equipment and prior to incorporation into the work.

The exception to obtaining the concrete sample at or near the point of discharge by the delivery equipment is when concrete is placed by pump or conveyor. When concrete is placed by pump or conveyor, obtain the field sample for strength specimens at the discharge end of the pump or conveyor.

Since concrete is accepted or rejected on tests from relatively small samples of concrete, it is very important that the sample be truly representative of the concrete batch. Samples shall not be obtained from the first 4 ft^3 (0.1 m^3) or from the last 4 ft^3 (0.1 m^3) of discharged concrete.

Occasionally, dry, sandy material may be discharged within the first 1/4 cubic yard (1/5 cubic meter). Concrete containing dry, sandy material shall be discarded before obtaining the sample.

When performing temperature, slump, and air content tests, a sample is normally taken immediately after 4 ft^3 (0.1 m^3) of concrete has been discharged unless dry, sandy material is encountered.

The size of sample is dependent on the type and number of tests to be conducted. For air and slump tests, small samples are sufficient. If strength specimens are to be made, larger samples are required. Do not be concerned with wasting small amounts of concrete.

For front discharge trucks, field experience indicates a better representative sample can be obtained by coating the interior discharge blades near the discharge opening. Expel the concrete until discharge is imminent, then move the concrete back to the original mixing position. Do this twice before discharging the concrete to obtain a sample.

Once the sample is obtained, move to a suitable location for performing tests and molding strength specimens.

Since the determination of temperature shall be completed within 5 minutes of obtaining the sample, it is good practice to insert the thermometer into the concrete immediately.

The slump and air tests shall be started within 5 minutes of obtaining the sample. (Note: Per Article 1020.12 for mobile portland cement concrete plants, it states: “Slump and air tests made immediately after discharge of the mix may be misleading, since the aggregates may absorb a significant amount of water for four or five minutes after mixing.” Therefore, in this situation, it is recommended to wait a minimum of 4 minutes before the start of slump and air tests.) Since the slump test shall be completed within 2 1/2 minutes, it is best to determine slump before starting the air test.

If strength specimens are necessary, molding shall begin within 15 minutes of obtaining the sample.

The following is a summary of the major steps for obtaining a representative sample of concrete for testing.

REPRESENTATIVE SAMPLE

Do not obtain the sample from the first 4 ft^3 (0.1 m^3), or from the last 4 ft^3 (0.1 m^3) of discharged concrete.

POINT OF SAMPLING

The field sample shall be obtained at or near the point of discharge by the delivery equipment and prior to incorporation into the work.

The exception to obtaining the concrete sample at or near the point of discharge by the delivery equipment is when concrete is placed by pump or conveyor.

When concrete is placed by pump or conveyor, the field sample for strength tests shall be obtained at the discharge end of the pump or conveyor. Per specifications, a slump test (or applicable self-consolidating concrete tests), air content test, and temperature test shall be performed on the same sample obtained for strength tests

Additional sampling prior to and following transport by pump or conveyor is specified to determine a correction factor for air content according to the Check Sheet for “Quality Control/Quality Assurance of Concrete Mixtures” or Construction Memorandum 13-74 “Guidelines for Pumping of Bridge Deck Concrete.”.

> **Note:** Field samples for strength tests are taken at the discharge end of the pump or conveyor because air content is likely to change during transport. Typically, if air content increases 1 percent, compressive strength will decrease approximately 2 to 6 percent and flexural strength will decrease approximately 2 to 4 percent. Note that these sampling and testing procedures are mandatory for bridge deck concrete transported by pump or conveyor. For some construction items, it may not be feasible or practical to obtain a field sample at the discharge end of the pump or conveyor. These samples may be obtained prior to pumping or conveying at the discretion of the Engineer.

SAMPLING FROM TRUCK MIXER, TRUCK AGITATOR, OR FRONT DISCHARGE CARRIER WHICH DEPOSIT CONCRETE WITH A CHUTE

1. Collect the sample in a damp, non-absorbent container (a wheelbarrow or other large container).

2. Repeatedly pass the sample container through the entire discharge stream, or completely divert the discharge stream into the sample container.

3. Protect the sample from contamination and if necessary, protect the sample from rapid evaporation by covering with a plastic sheet.

4. Transport the sample to the location of testing.

5. Remix the sample with a damp shovel.

6. Perform air content, slump, temperature, strength, and other tests as required. After completing a test, discard the concrete used. Never use any portion of the sample for more than one test.

7. Clean all test equipment with water and allow to drain, or wipe dry. Never assemble wet test equipment before storing.

SAMPLING FROM NONAGITATOR TRUCK OR OTHER DELIVERY EQUIPMENT WHICH DEPOSIT CONCRETE DIRECTLY ONTO THE GRADE

1. Collect the sample in a damp, non-absorbent container (a wheelbarrow or other large container).

2. Use a damp shovel to obtain portions of the concrete from at least 5 locations of the pile, and composite into one test sample.

3. Be careful not to contaminate the sample by including underlying material.

4. Protect the sample from contamination and if necessary, protect the sample from rapid evaporation by covering with a plastic sheet.

5. Transport the sample to the location of testing.

6. Remix the sample with a damp shovel.

7. Perform air content, slump, temperature, strength, and other tests as required. After completing a test, discard the concrete used. Never use any portion of the sample for more than one test.

8. Clean all test equipment with water and allow to drain, or wipe dry. Never assemble wet test equipment before storing.

11.0 ILLINOIS MODIFIED ASTM C1064/C1064M — TEMPERATURE OF FRESHLY MIXED PORTLAND CEMENT CONCRETE

Note: ASTM C 1064/C1064M is formerly AASHTO T 309.

Generally, the concrete temperature shall not be less than 50 °F (10 °C) nor more than 90 °F (32 °C). However, concrete temperature in superstructures shall not be more than 85 °F (30 °C). Furthermore, a maximum concrete temperature shall not apply to Class PP Concrete. For insulated forms involving cold weather, the concrete temperature shall not exceed 80 °F (25 °C). (Note: Insulated forms are frequently used in mass concrete applications, but the 80 °F (25 °C) maximum temperature does not apply. This is because the Contractor is required to submit a thermal control plan for mass concrete according to Article 1020.15.) Concrete temperature is normally checked “immediately before placement”. However, when concrete is pumped, the concrete temperature is checked ”at point of placement” because of the friction in the pipeline which causes additional heat gain in the concrete. Refer to Article 1020.14 for additional information regarding concrete temperature.

The concrete temperature shall be determined for the first load to arrive at the jobsite, and when strength specimens are molded. Concrete temperature should be determined whenever tests are performed at the plant or jobsite.

If the concrete temperature approaches or exceeds the specification limits, the Concrete Tester shall immediately notify the Level I or Level II PCC Technician. A batch of concrete not within the temperature specification limits shall be rejected by the Level I PCC Technician.

The following is a summary of the major steps for measuring the temperature of freshly mixed concrete.

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60. The sample size shall be sufficient to provide a minimum 3 in. (75 mm) concrete cover around the thermometer sensor in all directions.

2. Use an ASTM approved thermometer which is accurate to ±1° F (± 0.5° C), and has a range that is adequate for concrete temperatures encountered. Refer to Article 1020.14 for concrete temperature limitations.

3. Place the thermometer in the concrete sample, which was collected in a damp, non-absorbent container. The thermometer sensor shall be submerged a minimum of 3 in. (75 mm). The concrete temperature may also be measured in placement forms, or anywhere the minimum 3 in. (75 mm) cover is provided.

4. Gently press the concrete around the thermometer to prevent air temperature affects.

5. Read the temperature after a minimum of 2 minutes or when the temperature readings stabilize.

6. Complete the temperature measurement within 5 minutes after obtaining the sample.

7. Record the temperature to the nearest 1° F (0.5° C).

12.0 ILLINOIS MODIFIED AASHTO T 119 — SLUMP OF PORTLAND CEMENT CONCRETE

A concrete mixture must have workability, consistency, and plasticity which are suitable for job conditions. Workability is a measure of how easy or difficult it is to place, consolidate, and finish concrete. Consistency is the ability of freshly mixed concrete to flow. Plasticity determines concrete's ease of molding. A plastic concrete mixture will maintain suspension of the aggregates, and therefore the mixture is not likely to segregate during transportation/handling. Segregation occurs when the coarse aggregate separates from the mortar. Mortar consists of fine aggregate, cement, finely divided minerals, water, and air.

The slump test is used to determine the consistency of concrete. The types of consistency are stiff (low slump or poor flow) and fluid (high slump or excellent flow). The slump test is an indication of workability and plasticity, but should not be used to compare mixtures of different proportions. In addition, the slump test is not a good indicator of workability for a concrete mixture containing fiber reinforcement or high fines. In regards to high fines, an FA 20 is a good example of this.

Per Article 1020.04, different slump ranges are specified for different construction applications. Any change in slump is an indication that something has changed in the concrete mix. For example, assume the aggregates are of uniform consistency, and a fixed quantity of water has been added. A change in slump could indicate variations in aggregate gradations or air content, or errors in batching.

When a truck mixer arrives at the jobsite, listening to the noise that the mixer drum makes can be helpful. If the drum makes a swoosh noise as it turns, the mixture is less likely to need water than if a rattling noise is heard. However, do not guess a slump. Perform the test for accurate results to adjust the mixture.

The slump shall be determined for the first load arriving at the jobsite, and when strength specimens are molded. The Level I or Level II PCC Technician will provide the Concrete Tester the specification limits, testing frequency, and will indicate when to perform additional tests.

If the concrete slump approaches or exceeds the specification limits, the Concrete Tester shall immediately notify the Level I or Level II PCC Technician. Slump not within the specification limits may be adjusted. The Level I PCC Technician shall reject the batch of concrete if the attempt to adjust the slump is unsuccessful for meeting the specification limits. However, the Engineer has the option to permit the use of the batch of concrete represented. Refer to Article 1020.07 for additional information.

The following is a summary of the major steps for determining the slump of concrete.

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60.

2. Dampen the funnel, the cone, the hand scoop or trowel, the tamping rod, and the floor or base plate.

3. Conduct the test on a flat, level, firm, non-absorbent surface which is free of vibration or other disturbances.

4. Hold the cone firmly in place by standing on the two foot pieces, or by closing the clamps on the base plate. Do not allow the cone to move during filling.

5. Immediately fill the cone in three layers, each approximately one-third the volume of the cone. The bottom layer shall fill the cone to approximately one-quarter its depth [2 5/8 in. (67 mm)], the middle layer to approximately one-half its depth [6 1/8 in. (155 mm)], and the top layer to just over the top of the cone. Each scoopful of concrete should be moved around the top edge of the cone, (or funnel, if used), to provide even distribution of the concrete in the cone. If the funnel is used when placing the top layer, raise it slightly to prevent it from becoming wedged inside the cone.

6. If the funnel is used, remove it before rodding each layer. Rod each layer 25 times with the hemispherical end of the tamping rod. Distribute the rod strokes uniformly over the cross section of each layer. This will also require the tamping rod at times, to be inclined slightly. Rod approximately half of the strokes near the perimeter, and then progress with vertical strokes spirally toward the center.

7. Rod the bottom layer throughout its depth and avoid forcibly striking the floor or base plate. To accomplish this, hold the tamping rod at the point which will allow the desirable tamping depth.

8. Rod the middle and top layers to just penetrate into the underlying layer. To accomplish this, hold the tamping rod at the point which will allow the desirable tamping depth.

9. When rodding the top layer, keep the level of concrete above the cone at all times. If the level of concrete drops below the top of the cone, stop rodding and add more concrete. The rodding count shall resume at the point of interruption.

10. Strike off the concrete level with the top of the cone using a screeding and rolling motion with the tamping rod.

11. Hold the cone, without movement, by applying a downward force to the handles. Step off the foot pieces, or unclamp the base plate clamps, and immediately raise the cone above the concrete. This shall be performed in a steady upward lift with no lateral movement or rotation. The cone shall be lifted within 3 to 7 seconds. Steps 5 through 11 shall be performed within 2 1/2 minutes.

12. If a significant falling away or shearing off of concrete from one side occurs, do not measure the slump. Repeat the test on another portion of the sample. If the same result occurs, the concrete probably lacks the cohesiveness for the slump test to be applicable.

13. To measure the slump, invert the cone and place it on the floor or base plate near the slumped concrete. Place the tamping rod across the cone and immediately measure the distance between the bottom of the rod and the displaced original center of the top surface of the concrete. A base plate with a swing handle may also be used to measure the distance.

14. Record this measurement as the slump to the nearest 1/4 in. (5 mm).

13.0 ILLINOIS MODIFIED AASHTO T 152 — AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD

All concrete contains some amount of air. Air in concrete is either “entrapped” or “entrained”. Entrapped air is not effective for improving concrete quality. Entrained air improves concrete quality by providing extremely small air chambers, which relieve pressures caused by freezing water. Entrained air also improves concrete’s resistance to scaling caused by deicing salt. Concrete with entrained air has better workability, higher slump, less segregation, less bleed water, and reduced bleed time. Concrete with entrained air is more cohesive, but may be a “sticky” mixture.

Entrapped air bubbles, which are typically irregular in shape, are defined as bubbles equal to or greater than 1 mm in diameter. Entrapped air will range from 0.5 to 3 percent, but typically 1.5 to 2 percent entrapped air remains after the concrete is consolidated.

Entrained air bubbles, which are spherical or almost spherical in shape, are defined as bubbles smaller than 1 mm in diameter. Entrained air is normally produced by adding an air-entraining admixture to the concrete during mixing. Entrained air is rarely produced by using an air-entraining cement.

Note that it is not the air-entraining admixture that creates air bubbles. Air bubbles are created by the mixing process, and the shearing action of mixer blades breaks up large bubbles. The air-entraining admixture stabilizes and retains the air bubbles in a mixture by producing a film around them, making them less likely to break and escape.

The amount of air in concrete is determined by the air test. The test measures total air content, both entrapped and entrained. The Standard Specifications specify different air content ranges for different construction applications. One common air content range is 5% to 8%. Normally, concrete mix designs are based on the midpoint value of the air content range. Except for seal coat concrete (air entrainment optional) and bridge deck latex concrete overlay, all concrete and cement aggregate mixture II shall contain entrained air.

The air content is to be determined for the first load arriving at the jobsite, and when strength specimens are molded. The Level I or Level II PCC Technician will provide the Concrete Tester the specification limits, testing frequency, and will indicate when to perform additional tests.

The pressure test method is intended for use with concrete using relatively dense aggregates. The test is not applicable to concrete containing lightweight aggregates, high porosity aggregates, or air-cooled blast-furnace slag.

If the concrete air content approaches or exceeds the specification limits, the Concrete Tester shall immediately notify the Level I or Level II PCC Technician. Air content not within the specification limits may be adjusted. The Level I PCC Technician shall reject the batch of concrete if the attempt to adjust the air content is unsuccessful for the meeting the specification limits.

The following is a summary of the major steps for determining the air content of concrete by the pressure method.

Rodding Procedure [Slump is 1 in. (25 mm) or More]

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60.

2. Dampen the inside of the air meter bowl and top, the hand scoop or trowel, the tamping rod, and the strike-off bar. The strike-off bar is not required for the Type “A” Air Meter.

3. Place the bowl on a flat, level, firm surface. Fill the bowl in three equal layers by volume, slightly overfilling the top layer.

4. Rod each layer 25 times with the hemispherical end of the tamping rod, uniformly distributing the strokes. Distribute the rod strokes uniformly over the cross section of each layer.

5. Rod the bottom layer throughout its depth, without forcefully striking the bottom of the bowl.

6. Rod the middle and top layers about 1 in. (25 mm) into the underlying layer.

7. After rodding each layer (bottom, middle, and top), tap the sides of the bowl smartly 10-15 times with the mallet. This is to close any voids left by the tamping rod, and to release any large bubbles of entrapped air.

8. After consolidation of the top layer, the bowl should be slightly overfilled. If underfilled, or overfilled more than about 1/8 in. (3 mm), add or remove concrete with the hand scoop or trowel. Strike off the concrete level with the top of the bowl using the strike-off bar (tamping rod for the Type “A” Air Meter) and clean off the rim.

9. Thoroughly clean the flange or rim of the bowl and moisten the cover assembly. This will ensure that when the cover is clamped, a pressure-tight seal will be obtained.

Vibration Procedure [Slump is 3 in. (75 mm) or Less]

1. See steps 1 and 2 of the “Rodding Procedure”.

2. Place the bowl on a flat, level, firm surface. Fill the bowl in two equal layers by volume, slightly overfilling the top layer.

3. Insert the vibrator at three uniformly distributed points for each layer.

4. Do not allow the vibrator to contact the bottom or sides of the bowl.

5. When vibrating the top layer, allow the vibrator to penetrate about 1 in. (25 mm) into the bottom layer.

6. Vibrate only until the surface of the concrete becomes relatively smooth.

7. Remove the vibrator slowly to prevent air pockets. Do not use the mallet.

8. See Steps 8 and 9 of the “Rodding Procedure”.

Type "A" Air Meter

10. Close the lower petcock. Open the upper petcock and the funnel valve. Add water through the funnel until the level is slightly above the index mark, or until water flows from the upper petcock.

11. Close the funnel valve. Using the lower petcock, adjust the bottom of the meniscus (water level) to be level with the index mark. The index mark is to account for the expansion of the air meter, and is above the zero mark. The expansion is primarily a result of the C-clamps elongating. Always read the water level at the bottom of the meniscus. Close the lower petcock.

12. Close the upper petcock.

13. Using the hand pump, apply 103 kPa (15 psi) pressure.

14. Read the water level and record the **apparent air content** to the nearest tenth of a percent. If the water level cannot be read at 103 kPa (15 psi), reduce the air pressure to 69 kPa (10 psi) and multiply the reading by 1.25. If the water level cannot be read at 69 kPa (10 psi), reduce the air pressure to 34 kPa (5 psi) and multiply the reading by 2.00.

15. Calculate the air content by subtracting the aggregate correction factor from the apparent air content. The aggregate correction factor will be provided by the Level I or Level II PCC Technician.

    Air Content = Apparent Air Content - Aggregate Correction Factor

16. Record the air content to the nearest tenth of a percent.

17. Release the air pressure by slowly opening both petcocks before unclamping and removing the cover.

18. If the water glass needs cleaning, remove the valve from the funnel valve assembly. Clean the inside of the glass with a strip of cloth and one of the wire guards of the water glass.

19. Clean all test equipment with water and allow to drain, or wipe dry. Never assemble wet equipment before storing.

Type "B" Air Meter

10. Open both petcocks.

11. Close the main air valve between the air chamber and the bowl.

12. Using the syringe, slowly inject water through one petcock until it flows from the other.

13. Continue injecting water into the petcock while jarring the meter to ensure all air is expelled.

14. Pump air until the gauge needle is on the initial pressure line.

15. Allow a few seconds for the compressed air to cool.

16. Adjust the gauge needle to the initial pressure line by pumping in or bleeding off air. Lightly tap the gauge by hand to ensure the needle is not sticking.

17. When the needle is exactly on the initial pressure line, close both petcocks and immediately release the pressurized air into the bowl by depressing the lever.

18. While holding the air valve lever down, tap the sides of the bowl with the mallet and tap the pressure gauge lightly by hand to ensure the needle is not sticking.

19. Read the gauge and record the **apparent air content** to the nearest tenth of a percent.

20. Calculate the air content by subtracting the aggregate correction factor from the apparent air content. The aggregate correction factor will be provided by the Level I or Level II PCC Technician.

    Air Content = Apparent Air Content - Aggregate Correction Factor

21. Record the air content to the nearest tenth of a percent.

22. Release the air pressure by slowly opening both petcocks before unclamping and removing the cover.

    NOTE: Failure to close the main air valve before releasing pressure from either the bowl or the air chamber will result in water being drawn into the air chamber, thus introducing error into subsequent measurements. If water enters the air chamber, it must be removed through the bleeder valve by inverting and shaking the cover. This is followed by several strokes of the pump to blow out the last traces of water.

23. Clean all test equipment with water and allow to drain, or wipe dry. Never assemble wet equipment before storing.

    NOTE: Sources of test error using the Type A or B meter typically involve the following:
    - Improper consolidation.
    - Pressure gauge malfunction.
    - Petcock leak.
    - Improper fit of lid with bowl because of unclean surface.

14.0 ILLINOIS MODIFIED AASHTO T 23 — MAKING AND CURING CONCRETE TEST SPECIMENS IN THE FIELD

One of the most important properties of concrete is its strength. The purpose of strength testing is to verify the strength potential of the concrete. For most concrete construction, a compressive strength of 3,500 psi (24,000 kPa), or a flexural strength of 650 psi (4,500 kPa), at an age of 14 days is required. Refer to Article 1020.04 for additional information.

Note: For compressive strength testing, either 4- x 8-in. (100- x 200-mm) or 6- x 12-in. (150- x 300-mm) cylinders according to Illinois Modified AASHTO M 205 are allowed. The option to use 4- x 8-in. (100- x 200- mm) cylinders is effective January 1, 2014. Compressive strength shall be defined as the average of two 6- x 12-in. (150- x 300-mm) cylinder breaks or three 4- x 8-in. (100- x 200-mm) cylinder breaks. Furthermore, note that per Illinois Modified AASHTO T 23, cylinders shall be 6 by 12 in. (150 by 300 mm) when the nominal maximum size of the coarse

aggregate exceeds 1 in. (25.0 mm). For QC/QA projects, Engineer compressive strength split sample specimens will be the same size as those of the Contractor.

An air, slump, and temperature test is to be performed when making strength specimens. The Level I or Level II PCC Technician will provide the frequency to the Concrete Tester for making specimens, and when to make additional specimens.

Strength is determined by breaking test cylinders or beams. Plastic cylinder molds are 6 in. (152 mm) diameter by 12 in. (305 mm) height or 4 in. (100 mm) diameter by 8 in. (200 mm) height. Typical steel or plastic beams molds are as follows:

6 in. x 6 in. x 30 in. (152 mm x 152 mm x 762 mm)
6 in. x 6 in. x 21 in. (152 mm x 152 mm x 533 mm)
6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm)
6 in. x 6 in. x 19 in. (152 mm x 152 mm x 483 mm)
6 in. x 6 in. x 18 in. (152 mm x 152 mm x 457 mm).

The Department permits only the 762 mm (30 in.) beam to be used for two breaks. However, the disadvantage of this longer beam is the weight (mass) of the concrete and the mold. Assuming concrete has a weight (mass) of 150 lbs./cu.ft. (2400 kg/m^3), the weight (mass) of the concrete and 20 in. (508 mm) long steel mold is approximately 100 lbs (45 kg). The weight (mass) of the concrete and 30 in. (762 mm) long steel mold is approximately 145 lbs (65 kg).

After each time steel beam forms are used, they should be cleaned of concrete and coated with form release. Store the forms upside down to drain excess form release, and to keep the forms' interiors clean of dust and debris.

As soon as a strength specimen has been molded, it should be properly identified by writing on the outside of the cylinder or beam mold. Beam specimens may also be identified by inserting a weatherproof tag at one end of the mold. Do not scratch identification markings into the freshly molded specimen, as this will influence test results. When the strength specimen is removed from the mold, attach the identification tag to the specimen or mark the specimen with waterproof ink.

Any movement of a cylinder or beam within the first few hours after molding may be detrimental to strength. Thus, it is important that the specimens are molded in a place where they will not be disturbed. If this is not possible, move them to a safe place immediately after molding.

Strength specimens shall be protected from evaporation and cured in the field (initial curing) for no longer than 48 hours. After that, the specimens are moved to the laboratory for final curing. Careful handling and transportation of strength specimens to the location for final curing will avoid adverse test results. The following items are important to remember.

- Take measures to avoid impacts and jarring, when handling and transporting strength specimens. This can be accomplished by providing suitable cushioning material for the strength specimens. Typically, straw or burlap is used.

- Do not expose the strength specimens to cold or freezing temperatures. For example, transporting strength specimens in the open bed of a pickup is not a good idea. Especially on a cold day.

- Do not allow the strength specimens to incur moisture loss. This can be accomplished by wrapping the strength specimens in plastic, or covering the strength specimens with wet burlap.

The following is a summary of the major steps for making and curing test cylinders or beams.

Cylinder Consolidation By Rodding [Slump is 1 in. (25 mm) or More]

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60.

2. Dampen the hand scoop, the tamping rod, and the trowel or wood float.

3. Mold the cylinders on a flat, level, firm surface which is free of vibration or other disturbances.

4. Place the concrete in the mold, distributing it uniformly. Use the tamping rod to further distribute the concrete in the mold.

For 6 in. (150 mm) diameter by 12 in. (300 mm) height:

5. Fill the mold in three equal layers, slightly overfilling the top layer.

6. Rod each layer 25 times with the hemispherical end of the tamping rod. Distribute the rod strokes uniformly over the cross section of each layer.

7. Rod the bottom layer throughout its depth.

8. Rod the middle and top layers about 1 in. (25 mm) into the underlying layer.

9. After rodding each layer, lightly tap the sides of the mold 10 to 15 times with the mallet. This is to close any voids left by the tamping rod, and to release any large bubbles of entrapped air.

10. Strike off and finish the surface with a tamping rod, wood float, or trowel to produce a flat and even surface. Level the concrete with the top of the mold. Use a minimum amount of manipulation.

11. Immediately cover the surface. A plastic cylinder lid shall be the preferred method to cover cylinder molds.

12. Identify the specimen by writing on the outside of the mold. Do not inscribe the identification number in the surface of the concrete.

13. Store the specimens on a level surface, in an area where they will not be disturbed, and within a temperature range of 60° F to 80° F (16° C to 27° C) for up to 48 hours.

    Note: In some instances strength specimens are cured in the field in the same manner as the pavement or structure. Therefore, the previously mentioned temperature range would not apply.

For 4 in. (100 mm) diameter by 8 in. (200 mm) height:

5. Fill the mold in two equal layers, slightly overfilling the top layer.

6. Rod each layer 25 times with the hemispherical end of the tamping rod. Distribute the rod strokes uniformly over the cross section of each layer.

   Note: A smaller tamping rod (having dimensions 3/8 in. (10 mm) in diameter and 14 in. (350 mm) in length) is required for molding 4- x 8-in. (100- x 200-mm) compressive strength test cylinders.

7. Rod the bottom layer throughout its depth.

8. Rod top layer about 1 in. (25 mm) into the bottom layer.

9. After rodding each layer, lightly tap the sides of the mold 10 to 15 times with an open hand. This is to close any voids left by the tamping rod, and to release any large bubbles of entrapped air.

10. See steps 10 through 13 of the "Rodding Procedure" for 6 in. (150 mm) diameter by 12 in. (305 mm) height cylinders.

    Note: In some instances strength specimens are cured in the field in the same manner as the pavement or structure. Therefore, the previously mentioned temperature range would not apply.

Cylinder Consolidation By Vibration [Slump is 3 in. (75 mm) or Less]

1. See steps 1 through 4 of the "Rodding Procedure".

2. Fill the mold in two equal layers, slightly overfilling the top layer.

For 6 in. (150 mm) diameter by 12 in. (300 mm) height:

3. Insert the vibrator twice for each layer. Vibrate the concrete until it becomes relatively smooth and large air bubbles cease to break through the top surface. Be careful to withdraw the vibrator in such a manner that no air pockets are left in the specimen.

4. Do not allow the vibrator to contact the bottom or sides of the mold.

5. When vibrating the top layer, allow the vibrator to penetrate about 25 mm (1 in.) into the bottom layer.

6. Remember to vibrate only until the surface of the concrete becomes relatively smooth and large air bubbles cease to break through the top surface.

7. Remember to remove the vibrator slowly to prevent air pockets.

8. After each layer is vibrated, tap the outside of the mold at least 10 times with the mallet. This is to close any voids left by the vibrator, and to release any large bubbles of entrapped air.

9. See steps 10 through 13 of the "Rodding Procedure".

For 4 in. (100 mm) diameter by 8 in. (200 mm) height:

3. Insert the vibrator once for each layer. Vibrate the concrete until it becomes relatively smooth and large air bubbles cease to break through the top surface. Be careful to withdraw the vibrator in such a manner that no air pockets are left in the specimen.

4. Do not allow the vibrator to contact the bottom or sides of the mold.

5. When vibrating the top layer, allow the vibrator to penetrate about 25 mm (1 in.) into the bottom layer.

6. Remember to vibrate only until the surface of the concrete becomes relatively smooth and large air bubbles cease to break through the top surface.

7. Remember to remove the vibrator slowly to prevent air pockets.

8. After each layer is vibrated, tap the outside of the mold at least 10 times with an open hand. This is to close any voids left by the vibrator, and to release any large bubbles of entrapped air.

9. See steps 10 through 13 of the "Rodding Procedure".

Note: In some instances strength specimens are cured in the field in the same manner as the pavement or structure. Therefore, the previously mentioned temperature range would not apply.

Beam Consolidation By Rodding [Slump is 1 in. (25 mm) or More]

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60.

2. Dampen the hand scoop or shovel, the tamping rod, and the trowel or wood float. Apply a light coating of form release to the inside of the beam mold.

3. Mold the beams on a flat, level, firm surface which is free of vibration or other disturbances.

4. Place the concrete in the mold, distributing it uniformly. Use the scoop or shovel to further distribute the concrete in the mold.

5. Fill the mold in two equal layers, slightly overfilling the top layer.

6. If using the 30 in. (762 mm) beam, rod each layer 90 times with the hemispherical end of the tamping rod. If using the 21 in. (533 mm) beam, rod each layer 63 times. If using the 20 in. (508 mm) beam, rod each layer 60 times. If using the 19 in. (483 mm) beam, rod each layer 57 times. If using the 18 in. (457 mm) beam, rod each layer 54 times. Distribute the rod strokes uniformly over the cross section of each layer.

7. Rod the bottom layer throughout its depth.

8. Rod the top layer about 1 in. (25 mm) into the bottom layer.

9. After rodding each layer, tap the outside of the mold 10 to 15 times with the mallet. This is to close any voids left by the tamping rod, and to release any large bubbles of

entrapped air. After tapping, spade the sides and ends with a trowel or other tool to eliminate honeycombing.

10. Strike off and finish the surface with a tamping rod, wood float, or trowel to produce a flat and even surface. Level the concrete with the top of the mold and correct depressions or projections greater than 3 mm (1/8 in.). Use a minimum amount of manipulation.

11. Identify the specimen by writing on the outside of the mold or by inserting a weatherproof tag at one end of the mold. Do not inscribe the identification number in the surface of the concrete.

12. Immediately cover the surface. A plastic cover with an absorbent pad, saturated with water, shall be the preferred method to cover beam molds.

13. Store the specimens on a level surface, in an area where they will not be disturbed, and within a temperature range of 60° F to 80° F (16° C to 27° C) for up to 48 hours.

Note: In some instances strength specimens are cured in the field in the same manner as the pavement or structure. Therefore, the previously mentioned temperature range would not apply.

Beam Consolidation By Vibration [Slump is 3 in. (75 mm) or Less]

1. See steps 1 through 4 of the “Rodding Procedure”.

2. Fill the mold in one layer.

3. Insert the vibrator at intervals not exceeding 150 mm (6 in.) along the center line of the long dimension of the specimen. Vibrate the concrete until it becomes relatively smooth and large air bubbles cease to break through the top surface. Be careful to withdraw the vibrator in such a manner that no air pockets are left in the specimen.

4. Do not allow the vibrator to contact the bottom or sides of the mold.

5. After vibrating, tap the outside of the mold sharply at least 10 times with the mallet. This is to close any voids left by the vibrator, and to release any large bubbles of entrapped air. After tapping, spade the sides and ends with a trowel or other tool to eliminate honeycombing.

6. See steps 10 through 13 of the “Rodding Procedure”.

15.0 ILLINOIS MODIFIED AASHTO T 121 —DENSITY (UNIT WEIGHT), YIELD, AND AIR CONTENT (GRAVIMETRIC) OF CONCRETE

The unit weight test is used to check the yield of concrete, that is, the accuracy of proportioning. Yield is defined as the volume of freshly mixed concrete from a known quantity of materials. A lower unit weight/higher yield may indicate any of the following have changed:

- The aggregates may have a lower specific gravity.
- The air content may be higher.
- The water content may be higher.

- The cement factor may be lower.
- The proportion of ingredients may have changed.
- The weighing devices may not be operating properly.

A higher unit weight/lower yield would indicate the opposite trends, and is costly to the Contractor because there is a deficiency of concrete volume.

The Level I or Level II PCC Technician shall determine when a unit weight test is performed.

The following is a summary of the major steps for determining the unit weight of concrete.

1. Obtain the concrete sample according to Illinois Modified AASHTO R 60.
2. Determine and record the weight (mass) of the empty container.
3. Dampen the container, the hand scoop or trowel, the tamping rod, and the strike-off plate.

Rodding Procedure [Slump is 1 in. (25 mm) or More]

4. Place the container on a flat, level, firm surface. Fill the container in three equal layers by volume, slightly overfilling the top layer.
5. Rod each layer 25 times for a 0.5 $ft.^3$ (0.014 m^3) or smaller container with the hemispherical end of the tamping rod. Distribute the rod strokes uniformly over the cross section of each layer.
6. Rod the bottom layer throughout its depth, without forcefully striking the bottom of the container.
7. Rod the middle and top layers about 25 mm (1 in.) into the underlying layer.
8. After rodding each layer, tap the sides of the container smartly 10 to 15 times with the mallet. This is to close any voids left by the tamping rod, and to release any large bubbles of entrapped air.
9. After consolidation of the top layer, the container should be slightly overfilled. If underfilled, or overfilled more than about 3 mm (1/8 in.), add or remove concrete with the hand scoop or trowel. Strike off the concrete level with the top of the container using the strike-off plate and clean off the rim.
10. Determine and record the total weight (mass) of the container and concrete.
11. Clean all test equipment with water and allow to drain, or wipe dry.
12. Provide the values obtained in Steps 2 and 10 to the Level I or the Level II PCC Technician for determination of the unit weight.

Vibration Procedure [Slump is 3 in. (75 mm) or Less]

4. Place the container on a flat, level, firm surface. Fill the container in two equal layers by volume, slightly overfilling the top layer.

5. Insert the vibrator at three uniformly distributed points for each layer.

6. Do not allow the vibrator to contact the bottom or sides of the container.

7. When vibrating the top layer, allow the vibrator to penetrate about 1 in. (25 mm) into the bottom layer.

8. Vibrate only until the surface of the concrete becomes relatively smooth.

9. Remove the vibrator slowly to prevent air pockets. Do not use the mallet.

10. See steps 9 through 12 of the “Rodding Procedure”.

16.0 ILLINOIS MODIFIED AASHTO T 196 — AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE VOLUMETRIC METHOD

The volumetric test method is applicable to concrete using any type of aggregate, whether it be dense, lightweight, high porosity, or air-cooled blast-furnace slag. This test is rarely required. Therefore, the Level I or Level II PCC Technician will either perform this test or teach the Concrete Tester how to do it.

17.0 ADDING WATER AND ADMIXTURES

A Concrete Tester shall not determine adjustments to a concrete mixture. This is the responsibility of the Level I or Level II PCC Technician. However, the Concrete Tester may assist with adding water or an admixture.

Adjustments to the concrete mixture may be performed at the plant, but are more frequently done at the jobsite. For example, water or an air-entraining admixture are frequently added at the jobsite. The reason is to adjust the concrete mixture, to meet the Standard Specification placement requirements.

Admixtures are also added to obtain a concrete mixture with specific properties. For example, a high-range water-reducing admixture (superplasticizer) is added to produce a highly fluid and workable concrete mixture. A maximum slump of 7 in. (180 mm) is typical. A superplasticizer is normally added at the jobsite, because of its 30 to 60 minute life. Another admixture frequently used is an accelerator, since it will cause a rapid stiffening of the concrete mixture. An accelerator is normally added at the jobsite, to ensure the truck mixer can discharge the rapid setting concrete.

The procedure for adding water or an admixture follows:

- Adding Water

  The procedure to add water is as follows:

  - ♦ Add the quantity of water instructed by the Level I or Level II PCC Technician. Normally, 1 gallon (5 liters) of water per cubic meter (cubic yard) of concrete will raise the slump 1 in. (25 mm). The addition rate for increasing slump will normally increase air content 0.5 to 1 percent. This is a result of more water available, which improves the effectiveness of the air-entraining admixture.

- ♦ Mix the concrete a minimum of 40 revolutions at mixing speed. The mixing speed for the truck mixer shall be per the manufacturer's rating plate.

- ♦ Retest the slump and air content.

- ♦ Notify the Level I or Level II PCC Technician of the test results.

- Adding Air-Entraining Admixture

  The procedure to add an air-entraining admixture is as follows:

  - ♦ Add the quantity of air-entraining admixture instructed by the Level I or Level II PCC Technician. Normally, 1 oz. (40 ml) of admixture per cubic yard (cubic meter) of concrete will raise the air content 1 percent. Mix the air-entraining admixture with approximately 3 to 5 gallons (10 to 20 liters) of water in a bucket and pour over the concrete. To do this, it may be necessary to ask the driver to move the concrete to the rear of the drum with discharge imminent. In some cases, the Level I or Level II PCC Technician may require the air-entraining admixture to be mixed with less than 3 gallons (10 liters).

  - ♦ Mix the concrete a minimum of 40 revolutions at mixing speed. The mixing speed for the truck mixer shall be per the manufacturer's rating plate. To ensure folding of the mixture to generate air, do not mix too fast because the centrifugal force may pin the mixture to the side of the drum.

  - ♦ Retest the air content and slump.

  - ♦ Notify the Level I or Level II PCC Technician of the test results.

- Adding A Superplasticizer

  The procedure to add a superplasticizer is as follows:

  - ♦ An initial minimum slump of 1 1/2 in. (40 mm) is required prior to the addition of the superplasticizer, except as approved by the Engineer.

  - ♦ Add the quantity of superplasticizer instructed by the Level I or Level II PCC Technician.

  - ♦ The concrete in the truck mixer shall be moved to the rear of the drum with discharge imminent.

  - ♦ The superplasticizer shall be added by dispensing directly onto the concrete.

  - ♦ Mix the concrete the number of revolutions instructed by the Level I or Level II PCC Technician. Do not mix the concrete less than 40 revolutions. The mixing speed for the truck mixer shall be per the manufacturer's rating plate.

  - ♦ Perform a slump and air content test.

  - ♦ Notify the Level I or Level II PCC Technician of the test results.

- Adding An Accelerating Admixture

  The procedure to adding an accelerating admixture is as follows:

  - ♦ Add the quantity of accelerating admixture instructed by the Level I or Level II PCC Technician.
  - ♦ The concrete in the truck mixer shall be moved to the rear of the drum with discharge imminent.
  - ♦ The accelerator shall be added by dispensing directly onto the concrete.
  - ♦ Mix the concrete a minimum of 40 revolutions at mixing speed. The mixing speed for the truck mixer shall be per the manufacturer's rating plate.
  - ♦ Perform a slump and air content test.
  - ♦ Notify the Level I or Level II PCC Technician of the test results.

18.0 OBSERVING THE CONCRETE MIXTURE

If the following situations are observed either at the plant or jobsite, immediately notify the Level I or Level II PCC Technician:

- Uncoated Aggregates - Concrete containing uncoated aggregates is to be discarded by the Contractor.
- Segregation - Segregation occurs when the coarse aggregate separates from the mortar. Mortar consists of fine aggregate, cement, finely divided minerals, water, and air.

  If segregation occurs, check for lower air content and the transport/handling method used.

- Microball - A microball is a clump of material containing cement on the outside and microsilica on the inside. A microball is normally 2 in. (50 mm) or less in diameter, and very hard to detect in a batch of concrete. The Level I PCC Technician shall reject the entire batch of concrete if a microball is observed.

  The Department has experienced numerous popouts on microsilica bridge deck overlays, because of microballs. These popouts will appear after the overlay experiences one or more freeze/thaw cycles.

- Cement Ball - A cement ball is a clump of material containing cement, fine aggregate, and coarse aggregate possibly resulting from dry materials being packed into the truck mixer and are not adequately mixed. During discharge, lumps of packed unmixed material will break loose.

  Occasional cement balls can be removed by the Contractor during placement.

- Sand Streaks - Sand streaks consist of fine aggregate, or fine aggregate and cement that have become packed in the head of the truck mixer and not adequately mixed. Occasionally, dry fine aggregate material will also pack around or behind the blades, in the discharge end of the drum. Concrete containing sandy material is to be discarded by the Contractor.

- Change In Color - A change in concrete color may be an indication of a change in materials, incomplete mixing, or too little cement.

- Change In Appearance - A change in appearance, such as a sticky mixture, may indicate too many fine materials (e.g. cement or finely divided minerals). A sticky mixer may also indicate high air content.

- Mudballs - Mudballs can be introduced into concrete as a result of contaminated aggregate stockpiles. Aggregate stockpiles can be contaminated by mud which drops from hauling and loading equipment. Occasional mudballs can be removed by the Contractor during placement.

- Mix Foaming – Mix foaming or other detrimental material may be observed during placement or at the completion of a self-consolidating concrete pour. In this case, the material may be removed by the Contractor while the concrete is still plastic.

  Mix foaming is an indication that the self-consolidating concrete is not cohesive (or stable) and may have excess water.

19.0 SELF-CONSOLIDATING CONCRETE (SCC)

SCC is a flowable concrete mixture that does not require mechanical vibration for consolidation. The concrete mixture is increasingly being used to obtain a high quality surface finish with few bugholes. The Level I or Level II PCC Technician will either perform the various tests or teach the Concrete Tester how to perform them. A copy of the test methods is provided in Appendix A.

The student will not be tested on these test methods.

20.0 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

CLSM is a self-consolidating mortar mixture, which is typically used as a backfill. The low strength of the material allows it to be subsequently excavated with conventional digging equipment. The Level I or Level II PCC Technician will either perform the various tests or teach the Concrete Tester how to perform them. A copy of the test methods is provided in Appendix B.

The student will not be tested on these test methods.

21.0 APPLICABLE SPECIFICATIONS

Although not a requirement, the Concrete Tester may want to be more familiar with the following Sections or Articles.

Article 285.05	Fabric Formed Concrete Revetment Mats
Article 312.09	Proportioning and Mix Design (Cement Aggregate Mixture II)
Section 1002.	Water
Section 1020.	Portland Cement Concrete
Article 1103.01.	Concrete Mixers

To view or download the Standard Specifications for Road and Bridge Construction on the Internet go to http://idot.illinois.gov/; Doing Business; Procurements; Construction Services; Contractor Resources. In addition to the Standard Specifications, it is important for the Concrete Tester to be familiar with the Supplemental Specifications and Recurring Special Provisions document and the Bureau of Design and Environment (BDE) Special Provisions. To view or download the Supplemental Specifications and Recurring Special Provisions on the Internet go to http://idot.illinois.gov/; Doing Business; Procurements; Construction Services; Contractor Resources. To view or download the Bureau of Design and Environment (BDE) Special Provision on the Internet go to http://idot.illinois.gov/; Doing Business; Procurement; Construction Services; Contractor Resources; Highways; Letting Specific Items. The Supplemental Specifications are a supplement to the Standard Specifications. The Recurring Special Provisions are frequently included by reference, in selected contracts. The BDE special Provisions are frequently included by insertion, in selected contracts.

The Concrete Tester should also be familiar with Guide Bridge Special Provisions (GBSP). To view or download Guide Bridge Special Provisions (GBSP) go to http://idot.illinois.gov/; Doing Business; Procurements; Construction Services; Contractor Resources; Supplemental Specifications and Recurring Special Provisions. The GBSP are frequently included by insertion, in selected contracts. As an example, the bridge deck fly ash or ground granulated blast-furnace slag overlay, microsilica overlay, high-reactivity metakaolin overlay, and latex concrete overlay Special Provisions are found in this area.

Appendix A

Illinois Test Procedure SCC-1
Effective Date: March 1, 2013

Standard Test Method for Sampling, Determining Yield and Air Content, and Making and Curing Strength Test Specimens of Self-Consolidating Concrete

I. SAMPLING OF FRESHLY MIXED CONCRETE

Sampling freshly mixed self-consolidating concrete (SCC) shall be performed according to Illinois Modified AASHTO R 60, except the elapsed time for obtaining the representative sample shall not exceed two minutes. The number of testing personnel shall be such that all tests shall start within five minutes of obtaining the representative sample.

II. YIELD AND AIR CONTENT OF FRESHLY MIXED CONCRETE

The yield test shall be according to Illinois Modified AASHTO T 121, except the measure shall be filled in one lift without vibration, rodding, or tapping. The air content test shall be according to Illinois Modified AASHTO T 152 or T 196, except the bowl shall be filled in one lift without vibration, rodding, or tapping.

III. MAKING AND CURING CONCRETE STRENGTH TEST SPECIMENS

Strength test specimens shall be made according to Illinois Modified AASHTO T 23 or R 39, except for the following:

a. The specimen molds shall be filled using a suitable container in one lift without vibration, rodding, or tapping.

b. Strike off the surface of the concrete level with the top of the mold using the strike-off bar or tamping rod.

c. The slump flow, VSI, air content, and temperature of each batch of concrete, from which specimens are made, shall be measured immediately after remixing.

This Page Reserved

Illinois Test Procedure SCC-2
Effective Date: April 1, 2008

Standard Test Method for Slump Flow and Stability of Self-Consolidating Concrete

Referenced Test Procedure(s):

1. Illinois Test Procedure SCC-1, Sampling, Determining Yield and Air Content, and Making and Curing Strength Test Specimens of Self-Consolidating Concrete

2. AASHTO T 119 (Illinois Modified), Slump of Hydraulic-Cement Concrete

3. ASTM E 29 (Illinois Modified), Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

To maintain brevity in the text, the following will apply:
Example: Illinois Test Procedure SCC-1 will be designated as “Illinois Test SCC-1.”
AASHTO T 119 (Illinois Modified) will be designated as “T 119.”
ASTM E 29 (Illinois Modified) will be designated as “ASTM E 29.”

1. GENERAL

This test method covers the determination of flowability and stability of fresh self-consolidating concrete (SCC). The average diameter of the slump flow is a measure of the filling ability (flowability) of SCC. The Visual Stability Index (VSI) is a measure of the dynamic segregation resistance (stability) of SCC.

All rounding shall be according to ASTM E 29.

2. EQUIPMENT

a. Mold and Tamping Rod – The mold and tamping rod shall conform to that described in T 119.

b. Strike-Off Bar – *Optional.* The strike-off bar shall be a flat straight bar at least 3 mm (0.125 in.) x 20 mm (0.75 in.) x 300 mm (12 in.).

c. Base Plate – The base plate shall be of a smooth, rigid, and nonabsorbent poly methyl methacrylate (e.g. Plexiglas®, Lucite®, etc.) or high-density overlay (HDO) plywood material, and be of sufficient dimensions to accommodate the maximum slump flow. *Optional*: Centered on the testing surface of the base plate shall be a marked circle of diameter 500 mm (20 in.).

d. Suitable container for filling inverted slump cone.

e. Measuring Tape – The measuring tape shall have a minimum gradation of 10 mm (0.5 in.).

f. Stopwatch – *Optional.* The stopwatch shall have a minimum reading of 0.2 seconds.

3. MATERIALS

The sample of SCC from which test specimens are made shall be obtained according to Section I of Illinois Test SCC-1.

4. PROCEDURE

a. Dampen the slump cone and base plate. Ensure excess water is removed from the testing surface as too much water may influence the Visual Stability Index (VSI) rating.

b. Place the base plate on level, stable ground. Center the mold on the base plate. The mold shall be placed inverted with the smaller diameter opening down.

c. Fill the mold in one lift without vibration, rodding, or tapping.

d. Strike off the surface of the concrete level with the top of the mold using the tamping rod or strike-off bar. Remove surplus concrete from around the base of the mold and base plate surface.

e. Raise the mold vertically a distance of 225 ± 75 mm (9 ± 3 in.) in 3 ± 1 seconds without any lateral or torsional motion. Complete the test procedure from the start of filling through removal of the mold without interruption and within an elapsed time of 2.5 minutes.

f. *Optional.* Measured from the time the mold is lifted, determine the time in seconds it takes for the concrete flow to reach a diameter of 500 mm (20 in.). This is the T_{50} time.

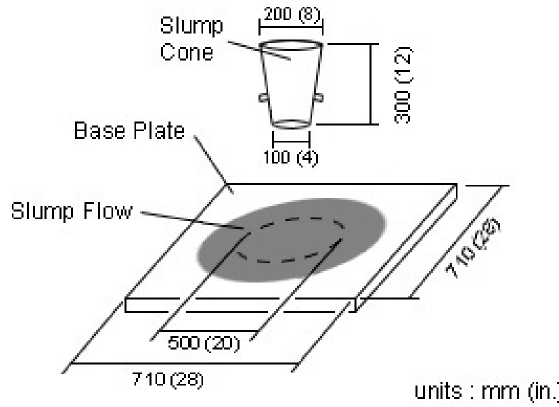

Figure 1. Slump Flow Test

g. When the concrete has stopped flowing, measure the maximum diameter of the resulting slump flow and measure the diameter perpendicular to the maximum. Each measurement shall be to the nearest 10 mm (0.5 in.). If the two measurements differ by more than 50 mm (2 in.), verify base plate to be level, and test again.

h. Calculate the average of the two measured diameters. This is the slump flow.

i. By visual examination, rate the Visual Stability Index (VSI) of the SCC using the criteria in Table 1 and illustrated in Figures 2 – 9.

Table 1 – Visual Stability Index (VSI)

VSI	Criteria
0 stable	No evidence of segregation or bleeding in slump flow, mixer drum/pan, or sampling receptacle (e.g. wheelbarrow).
1 stable	No mortar halo or coarse aggregate heaping in the slump flow, but some slight bleeding and/or air popping is evident on the surface of the slump flow, or concrete in the mixer drum/pan or sampling receptacle (e.g. wheelbarrow).
2 unstable	Slight mortar halo, ≤ 10 mm (0.5 in.) wide, and/or coarse aggregate heaping in the slump flow, and highly noticeable bleeding in the mixer drum/pan or sampling receptacle (e.g. wheelbarrow).
3 unstable	Clearly segregated by evidence of a large mortar halo, > 10 mm (0.5 in.), and/or large coarse aggregate pile in the slump flow, and a thick layer of paste on the surface of the concrete sample in the mixer drum or sampling receptacle (e.g. wheelbarrow).

5. REPORT

a. Report the slump flow (average of two measured diameters) to the nearest 5 mm (0.25 in.).

b. Report the VSI.

c. *Optional.* Report the T_{50} time to the nearest 0.2 second.

Figure 2. VSI = 0, stable

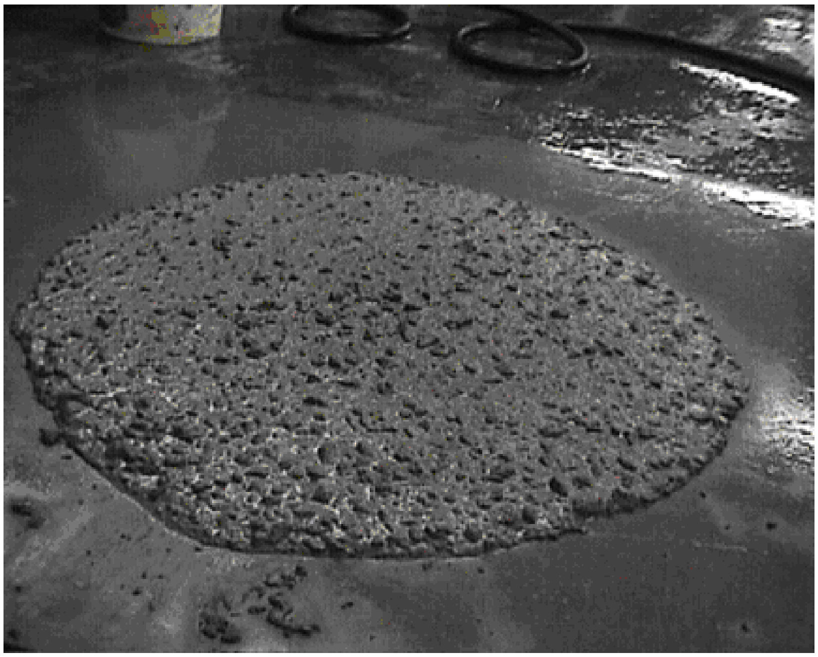

Figure 3. VSI = 0, stable

Figure 4. VSI = 1, stable

Figure 5. VSI = 1, stable

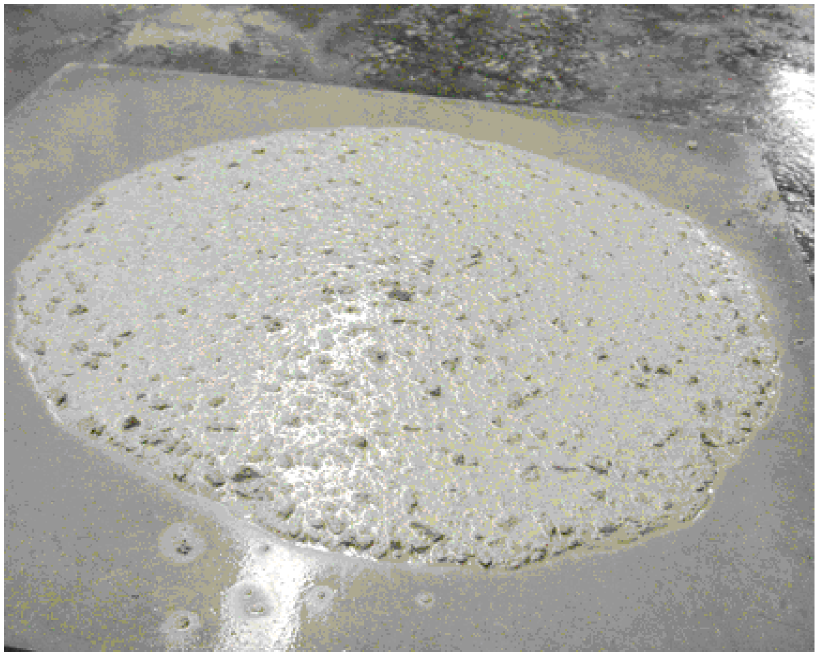

Figure 6. VSI = 2, unstable

Figure 7. VSI = 2, unstable

Figure 8. VSI = 3, unstable

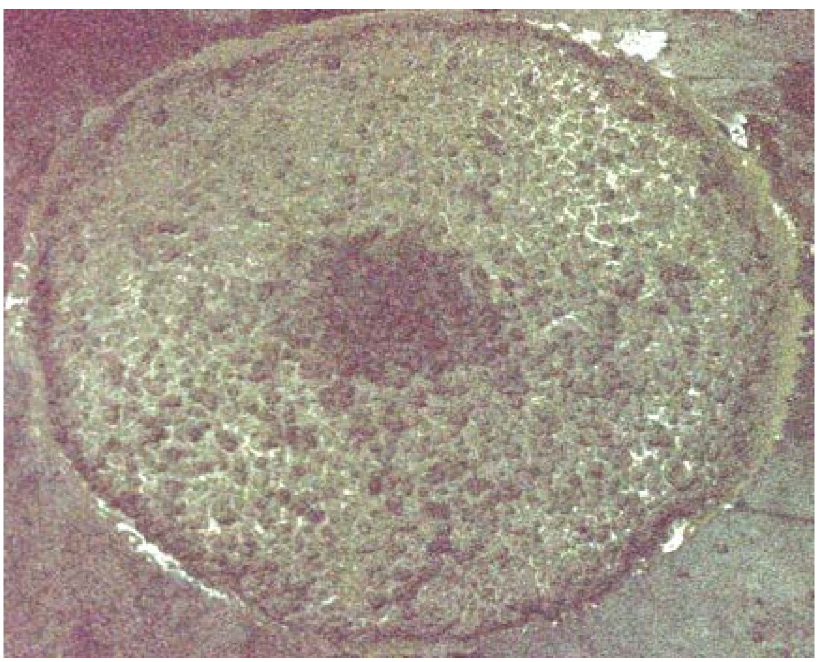

Figure 9. VSI = 3, unstable

Illinois Test Procedure SCC-3
Effective Date: May 1, 2007

Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring and Slump Cone

Referenced Test Procedure(s):

1. Illinois Test Procedure SCC-1, Sampling, Determining Yield and Air Content, and Making and Curing Strength Test Specimens of Self-Consolidating Concrete
2. Illinois Test Procedure SCC-2, Slump Flow and Stability of Self-Consolidating Concrete
3. AASHTO T 119 (Illinois Modified), Slump of Hydraulic-Cement Concrete
4. ASTM E 29 (Illinois Modified), Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

To maintain brevity in the text, the following will apply:
Example: Illinois Test Procedure SCC-1 will be designated as "Illinois Test SCC-1."
AASHTO T 119 (Illinois Modified) will be designated as "T 119."
ASTM E 29 (Illinois Modified) will be designated as "ASTM E 29."

1. GENERAL

This test method covers the determination of the flowability and passing ability of self-consolidating concrete (SCC) using the J-Ring and Slump Cone. The diameter of the unobstructed slump flow versus the obstructed slump flow passing through the J-Ring is a measure of the passing ability of SCC.

All rounding shall be according to ASTM E 29.

2. EQUIPMENT

a. J-Ring – See Figure 1. The J-Ring shall consist of sixteen evenly spaced smooth steel rods of 16 mm (5/8 in.) diameter and 100 mm (4 in.) length.
b. Mold and Tamping Rod – The mold and tamping rod shall conform to that described in T 119.
c. Strike-Off Bar – *Optional.* The strike-off bar shall be a flat straight bar minimum 3 x 20 x 300 mm (0.125 x 0.75 x 12 in.).
d. Base Plate – The base plate shall be of a smooth, rigid, nonabsorbent poly methyl methacrylate (e.g. Plexiglas®, Lucite®, etc.) or high-density overlay (HDO) plywood material, and be of sufficient dimensions to accommodate the maximum slump flow.
e. Suitable container for filling inverted slump cone.
f. Measuring Tape – The measuring tape shall have a minimum gradation of 10 mm (0.5 in.).

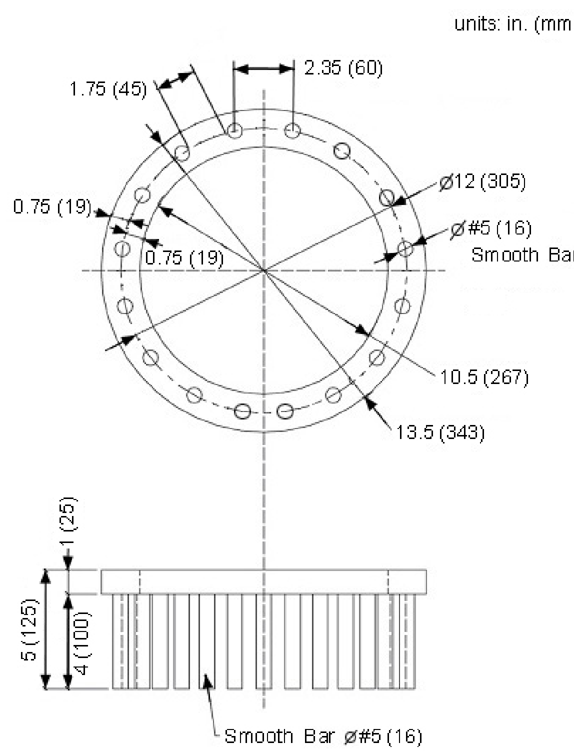

Figure 1. J-Ring Apparatus

3. MATERIALS

The sample of SCC from which test specimens are made shall be obtained according to Section I of Illinois Test SCC-1.

4. PROCEDURE

a. Dampen the J-Ring, slump cone, and base plate.

b. Place the base plate on level, stable ground. Center the J-Ring on the base plate. The mold shall be centered within the J-Ring and inverted with the smaller diameter opening down.

c. Fill the mold in one lift without vibration, roddding, or tapping.

d. Strike off the surface of the concrete level with the top of the mold using the tamping rod or strike-off bar. Remove surplus concrete from around the base of the mold and base plate surface.

e. Raise the mold vertically a distance of 225 ± 75 mm (9 ± 3 in.) in 3 ± 1 seconds without any lateral or torsional motion. Complete the test procedure from the start of filling through removal of the mold without interruption and within an elapsed time of 2.5 minutes.

f. When the concrete has stopped flowing, measure the maximum diameter of the resulting slump flow and measure the diameter perpendicular to the maximum. Each measurement shall be to the nearest 10 mm (0.5 in.). If the two measurements differ by more than 50 mm (2 in.), verify base plate to be level, and test again.

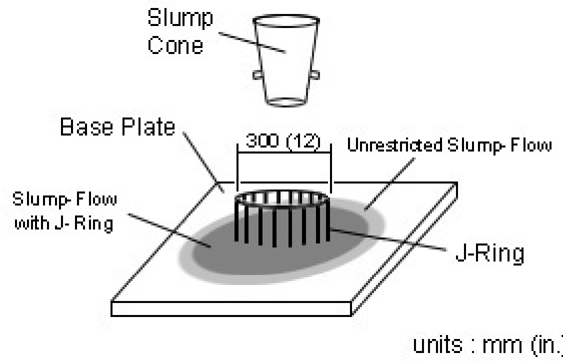

Figure 2. J-Ring Test

g. Calculate the average of the two measured diameters. This is the J-Ring flow.

h. Calculate the difference between the J-Ring flow and the unobstructed slump flow, as tested according to Illinois Test SCC-2, of the same representative sample. This is the J-Ring value. Rate the passing ability of SCC using the criteria in Table 1.

Table 1 – Passing Ability Rating

J-Ring Value, mm (in.)	Passing Ability Rating	Remarks
0 – 25 (0 – 1)	0	High passing ability
> 25 – 50 (> 1 – 2)	1	Moderate passing ability
> 50 (> 2)	2	Low passing ability

5. REPORT

a. Report the unobstructed slump flow (average of two measured diameters) and J-Ring flow (average of two measured diameters) to the nearest 5 mm (0.25 in.).

b. Report the J-Ring value and corresponding passing ability rating.

Illinois Test Procedure SCC-4
Effective Date: March 1, 2005

Standard Test Method for Passing Ability of Self-Consolidating Concrete by L-Box

Referenced Test Procedure(s):

1. Illinois Test Procedure SCC-1, Sampling, Determining Yield and Air Content, and Making and Curing Strength Test Specimens of Self-Consolidating Concrete

2. AASHTO T 119 (Illinois Modified), Slump of Hydraulic-Cement Concrete

3. ASTM E 29 (Illinois Modified), Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

To maintain brevity in the text, the following will apply:

Example: Illinois Test Procedure SCC-1 will be designated as "Illinois Test SCC-1."
AASHTO T 119 (Illinois Modified) will be designated as "T 119."
ASTM E 29 (Illinois Modified) will be designated as "ASTM E 29."

1. GENERAL

This test method covers the determination of the flowability and passing ability of self-consolidating concrete (SCC) using the L-Box. The flow heights ratio is a measure of the passing ability of SCC. The flow times (T_{20} and T_{40}) are a measure of the flowability of SCC.

All rounding shall be according to ASTM E 29.

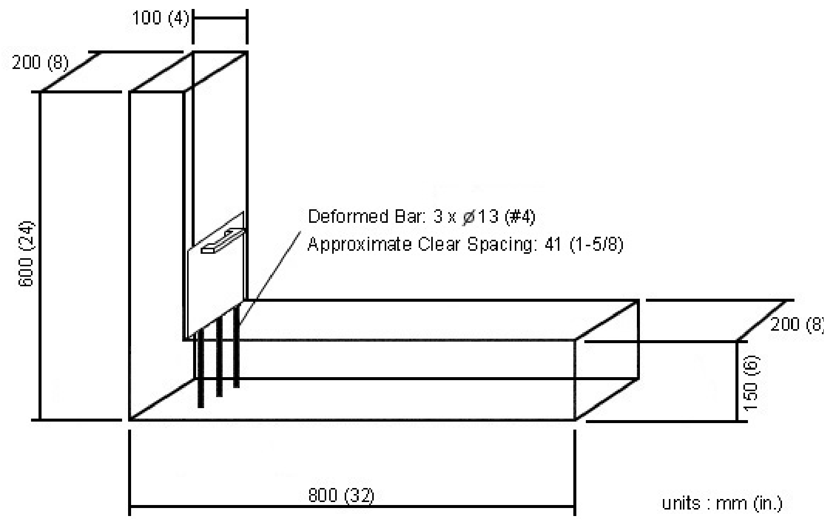

Figure 1. L-Box Apparatus

2. EQUIPMENT

a. L-Box – See Figure 1. The inside surface of the L-Box walls shall be of a smooth, rigid, nonabsorbent material.

b. Tamping Rod or Strike-Off Bar – The tamping rod shall conform to that described in T 119. The strike-off bar shall be a flat straight bar at least 3 mm (0.125 in.) x 20 mm (0.75 in.) x 300 mm (12 in.).

c. Suitable container for filling L-Box.

d. Measuring Tape – The measuring tape shall have a minimum gradation of 10 mm (0.5 in.).

e. Stopwatch – *Optional.* The stopwatch shall have a minimum reading of 0.2 seconds.

3. MATERIALS

The sample of SCC from which test specimens are made shall be obtained according to Section I of Illinois Test SCC-1.

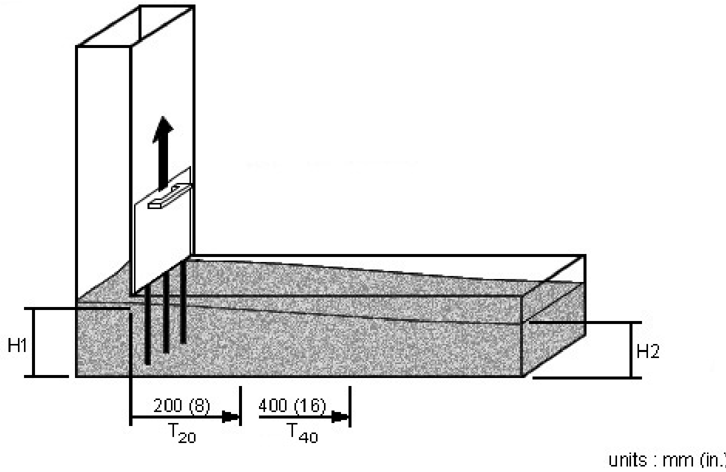

Figure 2. L-Box Test

4. PROCEDURE

a. Dampen the L-Box.

b. Place the L-Box on level, stable ground.

c. Ensure the sliding gate is shut, and fill the vertical of the L-Box in one lift without vibration, rodding, or tapping.

d. Strike off the surface of the concrete level with the top of the L-Box using the tamping rod or strike-off bar.

e. Allow the test specimen to stand for 1 minute.

f. Raise the sliding gate. Complete the test procedure from the start of filling through opening of the sliding gate without interruption and within 5 minutes.

g. *Optional.* Determine the time in seconds it takes for the concrete flow to travel 200 mm (8 in.) and 400 mm (16 in.), as measured from the time the sliding gate is lifted. These are the T_{20} and T_{40} times, respectively. Refer to Figure 2.

h. When the concrete has stopped flowing, measure the height of the resulting flow at the sliding gate, H1, and at the end of the horizontal, H2, to the nearest 5 mm (0.25 in.).

i. Calculate the blocking ratio as follows:

$$\textit{Blocking Ratio} = \frac{H2}{H1} \times 100$$

5. REPORT

a. Report the filling heights, H1 and H2, to the nearest 5 mm (0.25 in.).

b. Report the blocking ratio, H2/H1, to the nearest 1 percent.

c. Report observations of bleeding, and/or air popping on the surface of the concrete flow.

d. *Optional.* Report the T_{20} and T_{40} flow times to the nearest 0.2 second.

Illinois Test Procedure SCC-6
Effective Date: April 1, 2011

Standard Test Method for Static Segregation of Hardened Self-Consolidating Concrete Cylinders[1]

Referenced Test Procedure(s):

1. Illinois Test Procedure SCC-1, Sampling, Determining Yield and Air Content, and Making and Curing Strength Test Specimens of Self-Consolidating Concrete
2. AASHTO T 22 (Illinois Modified), Compressive Strength of Cylindrical Concrete Specimens
3. AASHTO T 23 (Illinois Modified), Making and Curing Concrete Test Specimens in the Field
4. AASHTO T 24, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. AASHTO T 119 (Illinois Modified), Slump of Hydraulic-Cement Concrete
6. AASHTO R 39 (Illinois Modified), Making and Curing Concrete Test Specimens in the Laboratory

To maintain brevity in the text, the following will apply:
Example: Illinois Test Procedure SCC-1 will be designated as "Illinois Test SCC-1."
AASHTO T 22 (Illinois Modified) will be designated as "T 22."

1. GENERAL

This test method covers the determination of the static segregation resistance (stability) of self-consolidating concrete (SCC). The visual assessment, using a Hardened Visual Stability Index (HVSI), of cast or cored hardened cylinders cut lengthwise in two is a measure of the stability of SCC.

2. EQUIPMENT

a. Mold – The mold shall be a 6 x 12 in. (150 x 300 mm) cylinder mold and conform to T 23 or R 39.
b. Tamping Rod or Strike-Off Bar – The tamping rod shall conform to that described in T 119. The strike-off bar shall be a flat straight bar at least 0.125 x 0.75 x 12 in. (3 x 20 x 300 mm).
c. Suitable container for filling specimen molds.
d. Saw – The saw shall have a diamond or silicon-carbide cutting edge and shall be capable of cutting specimens without excessive heating or shock.
e. Core Drill – The core drill shall have diamond impregnated bits attached to a core barrel.

3. MATERIALS

The sample of SCC from which fresh test specimens are made shall be obtained according to Section I of Illinois Test SCC-1. Cored specimens from hardened concrete shall be obtained according to T 24 and have a minimum diameter of 50 mm (2 in.). When necessary as determined by the Engineer, the core may be taken so that its axis is perpendicular to the concrete as it was originally placed as long as the core diameter is sufficiently large enough to assess extent of static segregation.

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: August 12, 2004). Test method submitted to AASHTO by Illinois Department of Transportation. The AASHTO version is similar and is known as AASHTO PP 58.

4. PROCEDURE

a. A minimum of two fresh test specimens shall be made according to T 23 or R 39, except for the following:

   i. The specimen molds shall be filled in one lift using a suitable container without vibration, rodding, or tapping.

   ii. Strike off the surface of the concrete level with the top of the mold using the strike-off bar or tamping rod.

   iii. The slump flow, VSI, air content, and temperature of each batch of concrete, from which specimens are made, shall be measured immediately after remixing.

b. Immediately after being struck off, the specimens shall be capped with a plastic cylinder lid and moved to the storage place where they will remain undisturbed. The specimens shall be assigned an identification number, and the date of molding, location of concrete, and mix design number shall be recorded.

c. Before being subjected to sawing, the specimens shall have had a minimum curing period of 24 hours at a minimum temperature of 16 °C (60 °F) ***or*** attained a minimum compressive strength of 6200 kPa (900 psi) according to T 22.

d. The specimens shall be saw cut lengthwise down the center through its diameter. If the specimen cannot be satisfactorily sawed smooth from lack of curing, then the remaining specimen(s) shall remain undisturbed for an additional minimum curing period of 24 hours before being subjected to sawing.

e. Make a visual assessment of the cut plane of the hardened concrete cylinder(s) using the criteria in Table 1 and illustrated in Figures 1 – 8. The cut plane shall be wetted to facilitate visual inspection.

Table 1 – Hardened Visual Stability Index (HVSI)

HVSI	**Criteria**
0 stable	No mortar layer at the top of the cut plane and no variance in size and percent area of coarse aggregate distribution from top to bottom.
1 stable	Slight mortar layer, less than or equal to 6 mm (1/4 in.) tall, at the top of the cut plane and slight variance in size and percent area of coarse aggregate distribution from top to bottom.
2 unstable	Mortar layer, less than or equal to 25 mm (1 in.) tall, at the top of the cut plane and distinct variance in size and percent area of coarse aggregate distribution from top to bottom.
3 unstable	Clearly segregated as evidenced by a mortar layer greater than 25 mm (1 in.) tall and considerable variance in size and percent area of coarse aggregate distribution from top to bottom.

5. REPORT

a. Report the identification number and required information for each hardened specimen.

b. Report the Hardened Visual Stability Index (HVSI) for each hardened specimen.

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: August 12, 2004). Test method submitted to AASHTO by Illinois Department of Transportation. The AASHTO version is similar and is known as AASHTO PP 58.

Single Coarse Aggregate Mixture

Uniformly Graded Coarse Aggregate Mixture

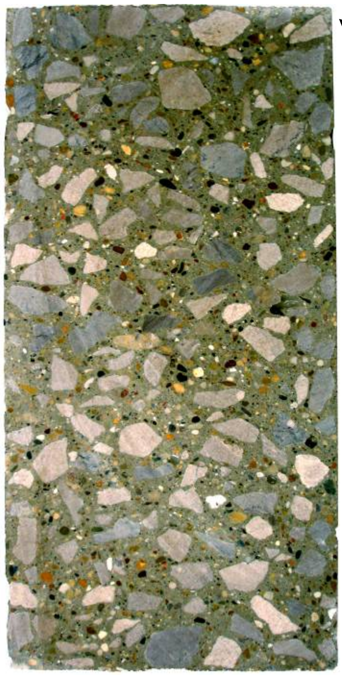

Figure 1. HVSI = 0, stable

No mortar layer.

Uniform distribution of coarse aggregate from top

Figure 2. HVSI = 0, stable

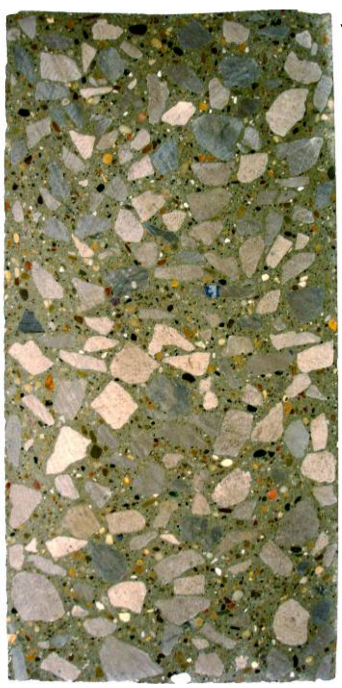

Figure 3. HVSI = 1, stable

Slight mortar layer, ≤ 6 mm (1/4 in.), and slight variance of coarse aggregate distribution from top

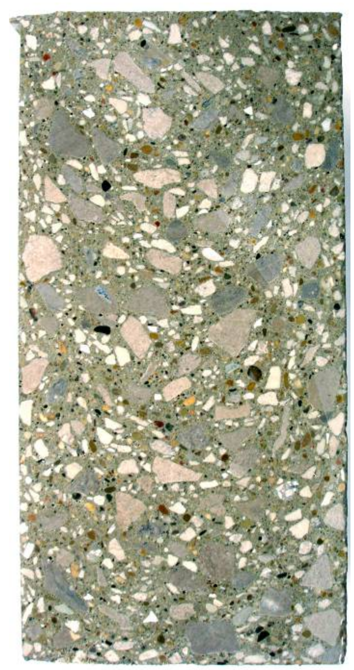

Figure 4. HVSI = 1, stable

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: August 12, 2004). Test method submitted to AASHTO by Illinois Department of Transportation. The AASHTO version is similar and is known as AASHTO PP 58.

Single Coarse Aggregate Mixture

Uniformly Graded Coarse Aggregate Mixture

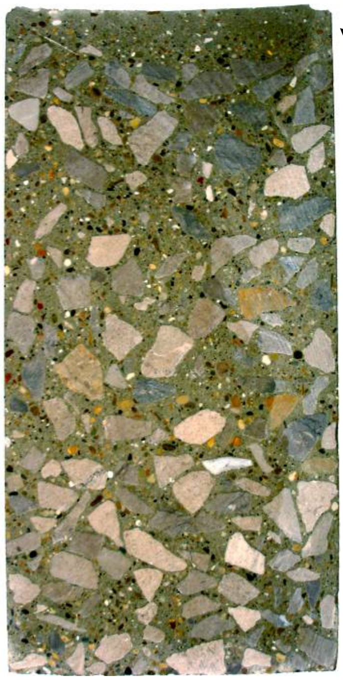

Figure 5. HVSI = 2, unstable

Visible mortar layer ≤ 1 in. (25 mm), and distinct variance of coarse aggregate distribution from top to bottom.

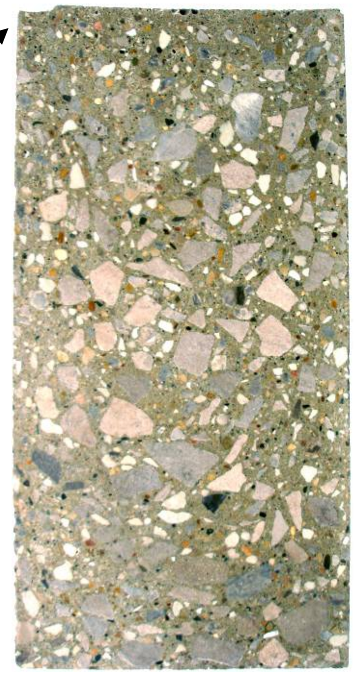

Figure 6. HVSI = 2, unstable

Figure 7. HVSI = 3, unstable

Visible Mortar layer > 1 in. (25 mm) and considerable variance of coarse aggregate distribution from top to bottom.

Note contrast at top. This is a layer of foam, which may be visible in any stable or unstable mix.

Figure 8. HVSI = 3, unstable

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: August 12, 2004). Test method submitted to AASHTO by Illinois Department of Transportation. The AASHTO version is similar and is known as AASHTO PP 58.

Illinois Test Procedure SCC-8
Effective Date: January 1, 2008
Revised Date: January 1, 2014

Test Method for Assessment of Dynamic Segregation of Self-Consolidating Concrete During Placement[1]

Referenced Test Procedure(s):

1. Illinois Test Procedure SCC-6, Standard Test Method for Static Segregation of Hardened Self-Consolidating Concrete Cylinders
2. Illinois Specification 101, Minimum Requirements for Electronic Balances
3. AASHTO M 92, Standard Specification for Wire Cloth Sieves for Testing Purposes
4. AASHTO T 23 (Illinois Modified), Making and Curing Concrete Test Specimens in the Field
5. AASHTO T 119 (Illinois Modified), Slump of Hydraulic-Cement Concrete
6. ASTM E 29 (Illinois Modified), Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

To maintain brevity in the text, the following will apply:
Example: Illinois Test Procedure SCC-1 will be designated as "Illinois Test SCC-1."
AASHTO T 23 (Illinois Modified) will be designated as "T 23."
ASTM E 29 (Illinois Modified) will be designated as "ASTM E 29."

1. GENERAL

This test method covers the evaluation of the dynamic segregation resistance (stability) of self-consolidating concrete (SCC). The visual assessment using a Hardened Visual Stability Index (HVSI) or the coarse aggregate weight (mass) retained ratio are measures of the stability of SCC.

All rounding shall be according to ASTM E 29.

2. EQUIPMENT

a. Specimen Mold – The mold shall be a 6 x 12 in. (150 x 300 mm) cylinder mold and conform to T 23.
b. Tamping Rod or Strike-Off Bar – The tamping rod shall conform to that described in T 119. The strike-off bar shall be a flat straight bar at least 0.125 x 0.75 x 12 in. (3 x 20 x 300 mm).
c. Suitable container for filling specimen molds.
d. Saw – *Procedure Option A only*, The saw shall have a diamond or silicon-carbide cutting edge and shall be capable of cutting specimens without excessive heating or shock.
e. Sieve – *Procedure Option C only*, The sieve shall be a No. 4 (4.75 mm) rectangular sieve of minimum dimensions 13 x 25 in. (330 x 635 mm) manufactured according to AASHTO M 92.
f. Balance – *Procedure Option C only*, The balance shall be according to Illinois Specification 101 for portland cement concrete unit weight measurements.

3. MATERIALS

Test specimens shall be made from separate samples of SCC obtained at or near 1) the point of discharge by deliver equipment, and 2) the point of flow termination as approved by the Engineer.

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: May 1, 2006).

4. PROCEDURE

Option A—For each of the two samples obtained (i.e., one at or near the point of discharge and another at point of flow termination), conduct testing according to Illinois Test SCC-6 for assessment of Hardened Visual Stability Index (HVSI).

Option B— Reserved.

Option C— Obtain two samples (i.e., one at or near the point of discharge and another at point of flow termination) and determine the Dynamic Segregation Index as follows:

a. Fill the mold in one lift without vibration, rodding, or tapping.

b. Strike off the surface of the concrete level with the top of the mold using the tamping rod or strike-off bar.

c. Wet wash over the No. 4 (4.75 mm) sieve the sample collected at or near the point of discharge.

d. Blot any free water from the retained coarse aggregate particles' surface with a towel to achieve a saturated surface dry (SSD) condition.

e. Determine the weight (mass) of the coarse aggregate to the nearest 0.1 lb. (50 g).

f. Repeat a. – e. for the sample collected at the point of flow termination.

g. Calculate the Dynamic Segregation Index (DSI) as follows:

$$DSI = \frac{(CA_1 - CA_2)}{CA_1} \times 100$$

Where: CA_1 = weight (mass) of coarse aggregate collected at or near the point of discharge
CA_2 = weight (mass) of coarse aggregate collected at the point of flow termination

5. REPORT

For all procedures,

a. Report maximum length of flow and maximum and minimum width of flow path.

b. Report approximate rate, feet per minute (meters per minute).

c. Report reinforcement bar size(s) and typical longitudinal and lateral spacing.

Procedure Option A only,

a. Report the Hardened Visual Stability Index (HVSI) rating for each hardened specimen.

Procedure Option B—Reserved.

Procedure Option C only,

a. Report the SSD weight (mass) of coarse aggregate collected at or near the point of discharge and point of flow termination, CA_1 and CA_2, respectively, to the nearest 0.1 lb. (50 g).

b. Report the Dynamic Segregation Index (DSI) to the nearest 1 percent.

[1]Test method developed by the Illinois Department of Transportation (Original Effective Date: May 1, 2006).

Appendix B

Illinois Test Procedure 307
Effective Date: April 1, 2009
Revised Date: January 1, 2015

Sampling and Testing of
Controlled Low-Strength Material (CLSM)

I. SAMPLING OF CLSM

Sampling freshly mixed controlled low-strength material (CLSM) shall be performed according to Illinois Modified AASHTO R 60, except the elapsed time for obtaining the composite sample shall not exceed two minutes. The flow test shall start within five minutes of obtaining the composite sample. The molding of strength test specimens shall start within ten minutes of obtaining the composite sample. The sample is to be routinely mixed during the testing process because CLSM may segregate.

II. TEMPERATURE OF CLSM

The temperature test shall be according to Illinois Modified ASTM C 1064.

III. FLOW CONSISTENCY OF CLSM

The flow test shall consist of filling a 76 mm (3 in.) inside diameter by 152 mm (6 in.) long plastic cylinder. The maximum variation from the normal inside diameter and length shall be 3 mm (1/8 in.). The plastic cylinder shall be smooth, rigid, nonabsorbent, and open at both ends. The test method shall consist of the following:

- Dampen the inside of the cylinder.
- Place the cylinder on a flat, level, firm nonabsorbent surface that is free of vibration or other disturbances.
- Hold the cylinder firmly in place and fill in one lift without vibration, rodding, or tapping.
- Strike off the top of the cylinder to form a level surface while holding the cylinder in place. Remove surplus material from around the base of the cylinder.
- Immediately raise the cylinder vertically a minimum distance of 150 mm (6 in.) in 3 ± 1 seconds without any lateral or torsional motion.
- When the material has stopped flowing, measure the maximum diameter of the resulting spread and measure the diameter perpendicular to the maximum. Each measurement shall be to the nearest 10 mm (0.5 in.). If the two measurements differ by more than 50 mm (2 in.), verify working surface to be level, and test again.
- Calculate the average of the two measured diameters and report to the nearest 5 mm (0.25 in.).

IV. AIR CONTENT OF CLSM

The air content test shall be according to Illinois Modified AASHTO T 121 or Illinois Modified AASHTO T 152, except the bowl shall be filled in one lift without vibration, rodding, or tapping.

V. COMPRESSIVE STRENGTH OF CLSM

Compressive strength test specimens shall be made and cured according to Illinois Modified AASHTO T 23, except for the following:

- The 152 mm x 305 mm (6 in. x 12 in.) cylinders shall be filled in one lift without vibration, rodding, or tapping. When bleed water appears at the top of the mold after a few minutes, the mold shall be refilled.

- The curing method shall be modified by not removing the covered specimen from the mold until the time of testing. The cylinders shall be stored in a shaded area with a controlled temperature of 16 °C to 27 °C (60 °F to 80 °F).

Compressive strength test specimens shall be tested according to Illinois Modified AASHTO T 22, except for the following:

- Neoprene caps shall be used for compressive testing, and a wire brush may be used to flatten test specimens that are not plane.

- The compression machine loading rate shall be 20 ± 10 kPa/s (3 ± 2 psi/s).

- Strength is defined as the average of two or more cylinder breaks.

- Compressive strength shall be calculated to the nearest 1.0 kPa (1.0 psi).