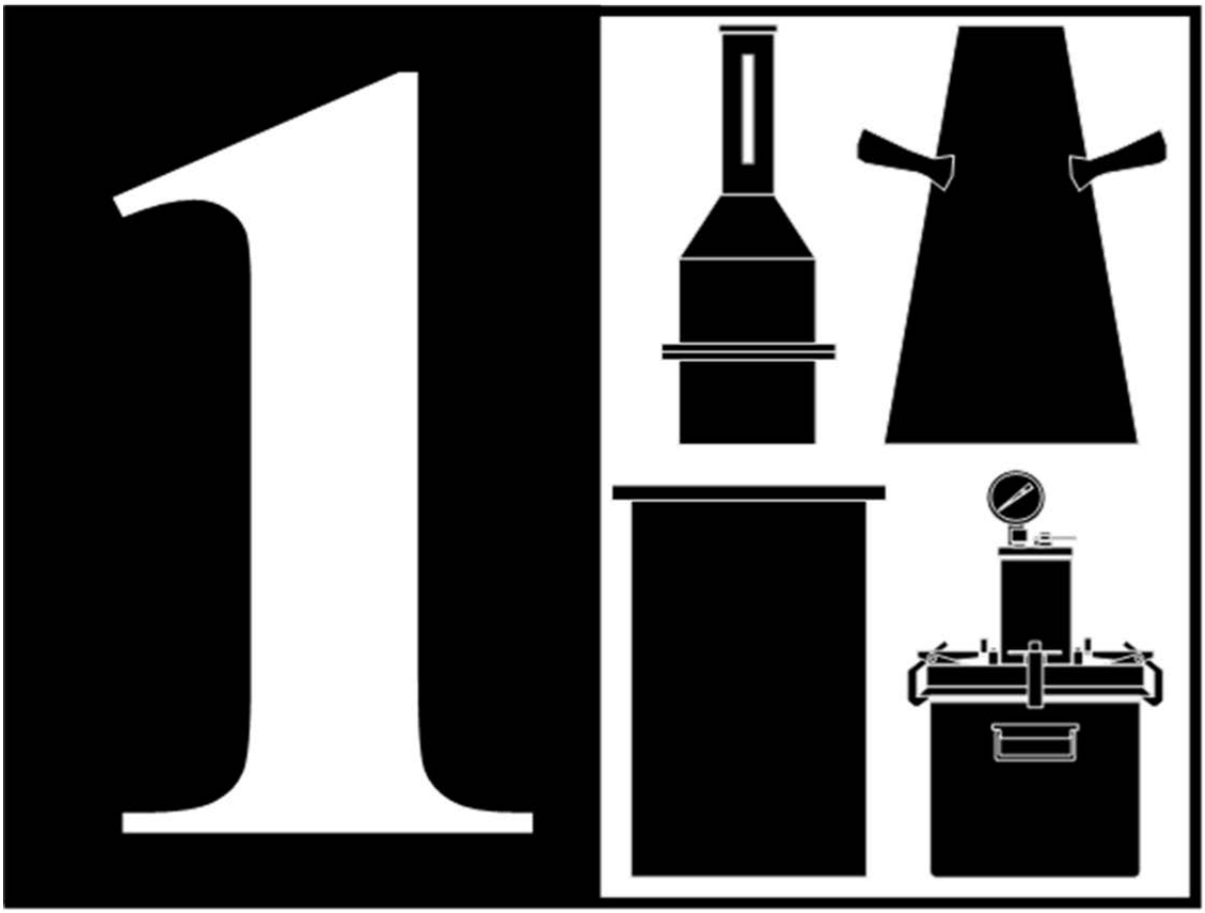
TDOT Department of Transportation



Concrete Field Testing Technician Course

Tennessee Department of Transportation

Volume 18.1

Concrete Field Testing Technician Course

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Concrete Field Testing Technician Course

Tennessee Department of Transportation

Volume 18.1

Class Schedule

Day 1:

1. Registration
2. Introduction
3. Sampling Freshly Mixed Concrete
4. Temperature of Freshly-Mixed Portland Cement Concrete
5. Slump of Hydraulic Cement Concrete
6. **Break**
7. Unit Weight (Density) and Yield of Concrete
8. Air Content of Freshly Mixed Concrete by the Pressure
9. Air Content of Freshly Mixed Concrete by the Volumetric Method
10. Making and Curing Concrete Test Specimens in the Field
11. **Lunch (Provided)**
12. Self-Consolidating Concrete (SCC)
13. Review Appendix

Day 2:

14. Review for Exam
15. Written Exam
16. Performance Exam

Concrete Field Testing Technician Course

Tennessee Department of Transportation

Volume 18.1

Table of Contents

Welcome!

Concrete Field Testing Technician Course

TN TDOT Department of Transportation

Introduction

- Technician Certification Program
- Purpose
- Who's Who
- Course Highlights
- Written Examination
- Results/Certification
- Resources/Contacts
- Summary/Questions

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Technician Certification Program

- Asphalt Roadway Inspector
- Asphalt Plant Inspector
- Asphalt Mix Design
- **Concrete Field Testing**
- Concrete Plant Quality Control
- Concrete Mix Design
- Soils and Aggregate
- Nuclear Gauge Safety (TDOT Employees Only)

Purpose of Certification

- To ensure proper performance of tests
- To improve reliability of results
- For quality control and acceptance
- To comply with federal requirements

Course Highlights

- Course schedule
  - Slide presentations
    - 7 Test methods for Concrete Field Testing
    - Self Consolidating Concrete
    - TDOT Specifications / Forms
  - Written exam
  - Performance exam
  - Results
  - Certification
- Recertification
  - Every 5 years

Written Examination

- Consists of:
  - **64** questions
  - Open-book
- To Pass:
  - Must get 70% overall on written exam
  - Must get 70% in each test section
  - **45 of 64** questions correct
  - Pass Performance Test

Results

- Available within one week of completion
- Contact the Headquarters Materials & Tests Training Coordinator, Kim Whitby
  - kimberly.whitby@tn.gov
  - 615-350-4158

Resources

- Course materials
  - Course textbook
  - Presentation slides and videos
- TDOT
  - Standard Specifications, January 1, 2015
  - Special Provisions
- Contacts
  - Region 1: Brad Baskette
  - Region 2: Tony Renfro
  - Region 3: Kevin Isenberg
  - Region 4: Mitch Blankenship

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Resources

- Tennessee Department of Transportation
  - https://www.tn.gov/tdot.html
- American Road & Transportation Builders Association
  - https://www.artba.org/
- Tennessee Road Builders Association
  - www.trba.org/
- Tennessee Ready Mixed Concrete Association
  - www.tnconcrete.org/
- American Association of State Highway Transportation Officials
  - https://www.transportation.org
- American Society for Testing and Materials
  - https://www.astm.org/
- American Concrete Institute
  - https://www.concrete.org/
- Construction Materials Engineering Council
  - https://www.cmec.org/
- Portland Cement Association
  - www.cement.org/

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ADA Notice of Requirements

- Can be found at the following website:
  - https://www.tn.gov/tdot/government/g/public-accessibility-office/ada.html
- To be in compliance with TDOTs requirements listed on the website above, it is our goal to provide reasonable accommodations to those who identify themselves as having a disability and request such accommodations.
- Please feel free to bring it to any of the course instructors and accommodations will be administered as discretely as possible.

Questions

1

Sampling Freshly Mixed Concrete

AASHTO R 60

ASTM C 172

TDOT Standard Method of Test for

Sampling Freshly Mixed Concrete

References

TDOT Standard Specifications
AASHTO R 60
ASTM C 172

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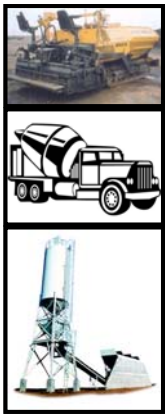
Scope

Procedure for obtaining representative samples of fresh concrete as delivered to the project site.

Tests will be performed for quality assurance in accordance with TDOT Specification.



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Sampling Sources

Method includes sampling from:

- ***Stationary Mixers & Revolving Drum Truck Mixers or Agitators***
  - **Collect two or more portions taken at regularly spaced intervals during discharge of the middle portion of the batch.**
  - **No sample shall be taken before 10% or after 90% of the batch has been discharged.**

- ***Paving Mixers***
  - **Obtain portions from at least five different portions of the pile and then composite into one sample for test purposes.**

Sampling

Elapsed time between obtaining first and final portions shall not exceed 15 minutes

Sampling

Transport individual samples to testing location then combine and remix to ensure uniformity.

Sampling

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

Sampling

Begin molding specimens for strength testing within 15 minutes after fabricating the composite sample.

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Sampling

Minimize the time between obtaining and using the sample

Protect the sample from

- **sun**
- **wind**
- **other sources of rapid evaporation**
- **contamination**

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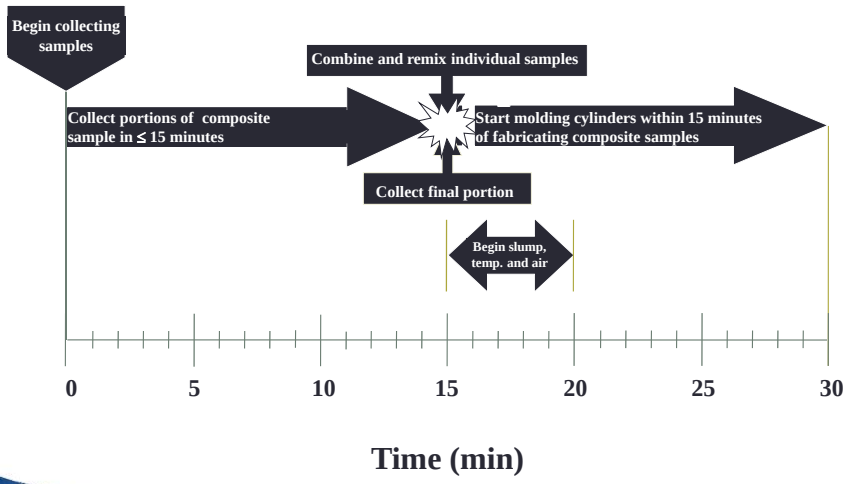
Sampling Timeline



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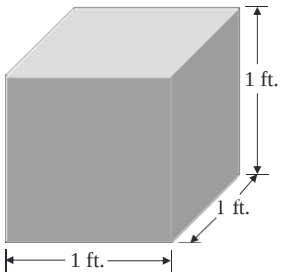
Procedure

- **Make samples to be used for strength tests a minimum of one cubic foot (1 ft^3).**
- **Smaller samples are allowed for routine air content and slump tests if cylinders are not being made.**



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Let's Review!

- What part of the batch do we sample from?
- How many portions make up a sample when sampling from the truck? When sampling from a paver?
- What is the maximum allowable time to obtain a complete sample?
- When do we start slump, temperature, and air?
- When do we begin making cylinders? What is the minimum sample size we need to cast cylinders?

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Questions?

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2

Temperature of Freshly Mixed

Hydraulic Cement Concrete

ASTM C 1064

TDOT Standard Method of Test for

Temperature of Freshly Mixed Hydraulic-Cement Concrete

References

TDOT Standard Specifications
ASTM C 1064

Equipment

Container

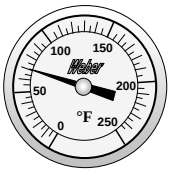
- **Made of nonabsorptive material**
- **Large enough to provide appropriate cover**
  - **At least 3 inches of cover in all directions around the tip of the thermometer**
  - **Concrete cover must also be at least 3 times the nominal maximum size of the coarse aggregate**

Equipment

Thermometer

- **Shall be capable of measuring the temperature of the concrete to ±1°F throughout the range (30°-120°F) likely to be encountered in freshly-mixed concrete.**
- **Calibrate once a year or whenever there is a question of accuracy.**

digital models



analog (dial) models

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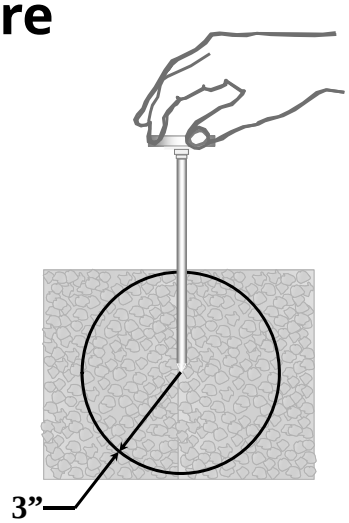
Procedure

- **Place the thermometer in the concrete so that the sensor is submerged a minimum of 3 inches with 3 inches of cover in all directions.**
- **If the nominal maximum aggregate size of the coarse aggregate is greater than 1 inch, cover must be at least 3 times the nominal maximum coarse aggregate size.**



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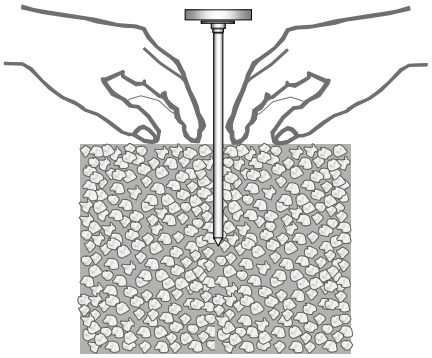
Procedure

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



Procedure

- Leave the thermometer in the concrete for a minimum of 2 minutes but not more than 5 minutes.
- While the thermometer is still in the concrete, read and then record the temperature to the nearest 1ºF.

Specifications

501.11 & 604.12

- **Mixing concrete shall discontinue when air temperature is 40°F and falling.**
- **Mixing of concrete shall not start/resume until air temperature is 35°F and rising.**
- **Concreting at air temperatures above 35°F**
  - **Concrete temperature at the time of placement shall be no less than 50°F nor more than 90°F**
- **When authorized concreting at air temperatures 35°F or less**
  - **The mixed, heated concrete shall not be less then 60°F nor more than 100°F at the time of placement.**

604.11

- **The concrete temperature at the point of discharge shall not exceed 90°F.**

Let's Review

- **What is the minimum concrete cover required? What if we are taking the temperature of Class CP?**
- **What is the required amount of time to leave the thermometer in the concrete?**
- **What do we record temperature to?**
- **What is the maximum allowable concrete temperature at the point of discharge?**

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3

Slump of Hydraulic Cement Concrete

AASHTO T 119

ASTM C 143

TDOT Standard Method of Test for

Slump of Hydraulic Cement Concrete

References

TDOT Standard Specifications
AASHTO T 119
ASTM C 143

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Summary of Test

- **Freshly-mixed concrete is sampled and compacted into a standard mold.**
- **The mold is removed and the concrete subsides.**
- **The distance between the mold height and the displaced concrete is measured.**
- **The measurement is reported as the *slump.***

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Purpose

- To measure the *consistency* of unhardened concrete
- To measure the *workability* of the concrete mixture
- To provide an approximation of the *water to cement ratio*
- To estimate the *strength* of the concrete

Purpose

- ***Consistency*** is the ability of freshly-mixed concrete to flow.
- For given proportions of cement and aggregate without admixture, the higher the slump, the wetter the mixture.

Purpose

- ***Workability*** **refers to, …the ease of placing, consolidating, and finishing freshly-mixed concrete.**
- **Concrete should be workable but should not segregate or bleed excessively.**

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Purpose

- **Under laboratory conditions, slump and *strength* are inversely proportional.**

$$high\ \frac{w}{cm} \Rightarrow weak\ concrete \qquad low\ \frac{w}{cm} \Rightarrow strong\ concrete$$

- **In field conditions, the slump and strength relationship is unclear and inconsistent.**

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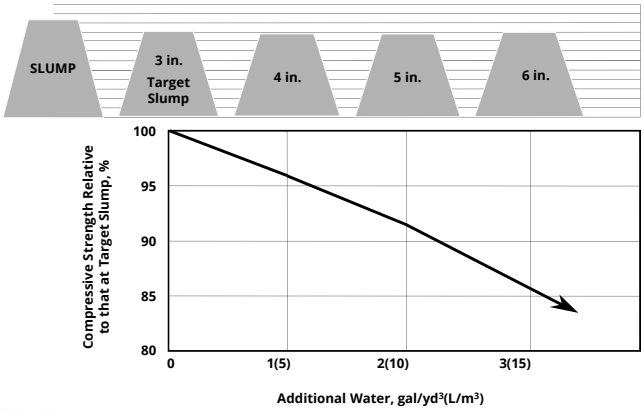
Purpose

Effect of Additional Water on Slump and Strength of Concrete



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Applicability

- **For plastic concrete with coarse aggregate up to 1½" in size.**
- **If aggregate is larger than 1½", then wet sieving of the larger particles are required.**
  - **Wet Sieving per AASHTO R-60**
    - **Pour concrete over 1½" sieve and shake/vibrate by hand or mechanical means.**
    - **Mix for uniformity the concrete that passes through the sieve.**

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Applicability

- ***Not*** **applicable for non-plastic concrete**
  slump < ½ in.

- ***Not*** **applicable for non-cohesive concrete**
  slump > 9 in.

Equipment

Ruler/Measuring Tape

- **At least 12 inches long**
- **Marked in increments of 0.25 inches or smaller**

Scoop

- **Large enough so concrete obtained from the sampling receptacle is representative**
- **Small enough so concrete is not spilled during placement in the mold**

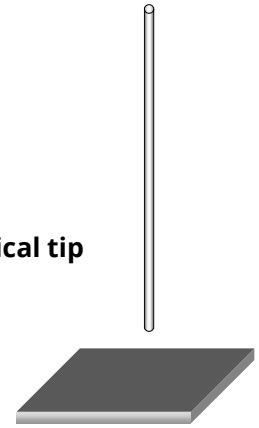
Equipment

Tamping rod

- Round, straight steel rod
- 5/8 ± 1/16" in diameter
- 16" - 24" long
- Tamping end rounded to a hemispherical tip

Base

- Flat, nonabsorbent



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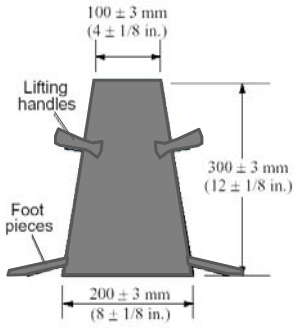
Equipment



Dimensions of slump cone

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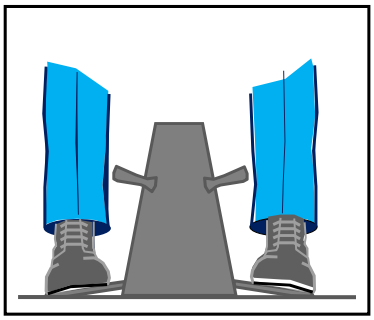
Procedure

- **Dampen the inside of the mold and the surface of the base.**
- **Place the mold onto the base (locking foot pieces)**

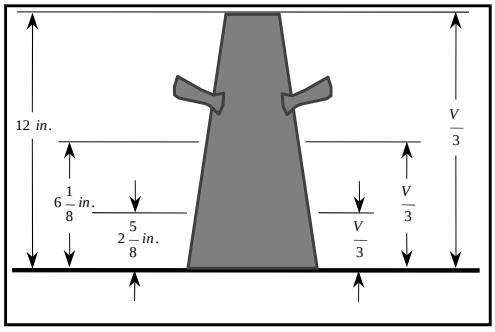
OR

- **Stand on the two foot pieces to hold the cone firmly in place.**



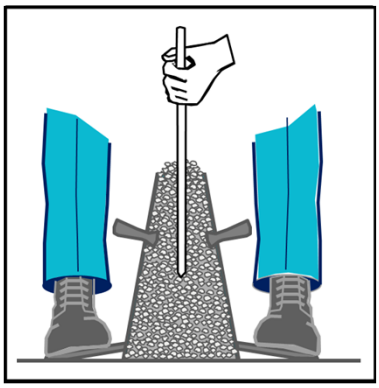
Procedure

- **Fill the mold in three layers.**
- **Each layer should be approximately 1/3 of the mold *volume.***
- **Fill the cone to overflowing on the last layer.**



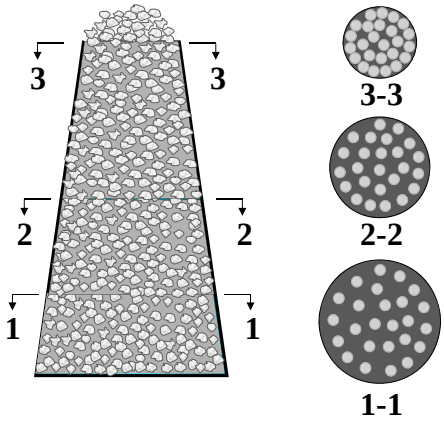
Procedure

- **Rod each layer with 25 strokes of the tamping rod.**
- **Tilt the tamping rod for the bottom (first) layer.**
- **When rodding the middle and last layers, penetrate approximately 1" into the previous layer.**



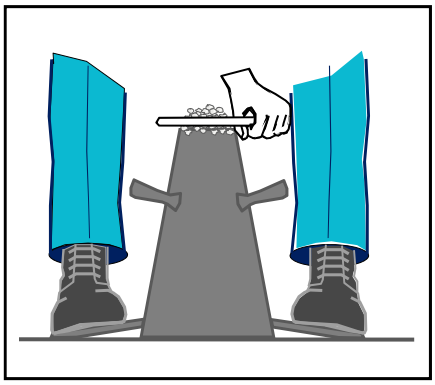
Procedure

- **Cross-section views showing uniform distribution of strokes**



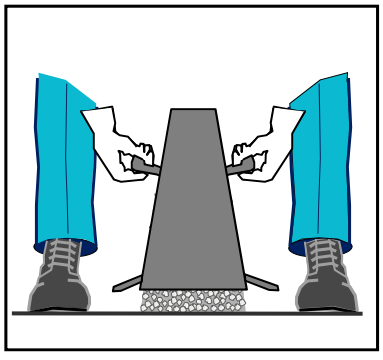
Procedure

- Strike off excess concrete from the cone by a means of screeding and rolling motion of the rod.
- Clean the concrete away from the base of the mold.



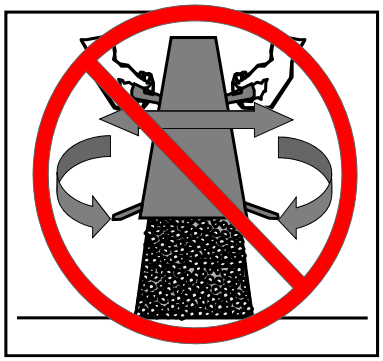
Procedure

- Raise the mold a distance of 12 inches in 5 ± 2 seconds
- Use a steady upward lift
- No lateral or torsional motion
- Complete entire test from the start without interruption in 2 ½ mins.



Procedure

- ***Do not*** **use lateral or torsional motion**



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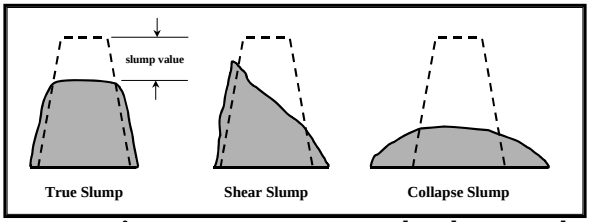
Procedure

- **If a shearing or collapse of the concrete mass is observed, disregard the results and perform the test again on another portion of the sample.**



- **If two consecutive tests on a sample show a shearing or collapse of the concrete mass, the concrete lacks the necessary plasticity and cohesiveness for the test to be applicable.**

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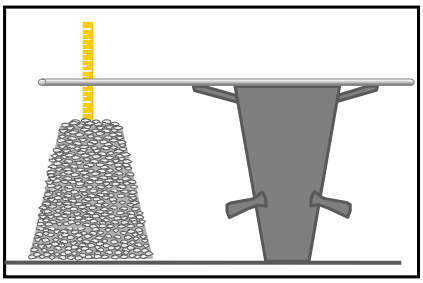
Procedure

- Place the steel rod horizontally across the inverted mold so that the rod extends over the slumped concrete.
- Immediately measure the distance from the bottom of the rod to the displaced center of the concrete.
- Record the slump in terms of inches to the nearest 1/4" of subsidence



Post-Testing Procedures

There is a substantial amount of cleanup required after the slump is measured and before the concrete has time to harden.

- Rinse out the slump cone. The slump cone must be cleaned so that the residue from the tested concrete won't bond to the cone.
- Clean all instruments used during the measurement procedure.
- Clean all of the concrete off of the baseplate and surrounding area.
- Dispose of all of the concrete.

Table 604.03-01
Composition of Various Classes of Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)	Slump (inches)
A	3,000	564	0.45	6 ± 2	3 ± 1 (1)
D, DS (2, 3)	4,000	620	0.40	7 (3)	8 max (4)
L (3, 5)	4,000	620	0.40	7 (3)	8 max (4)
S (Seal) (6)	3,000	682	0.47	6 ± 2	6 ± 2
X (7)					

(1) For slip forming, the slump shall range from 0 to 3 inches.

(4) Water reducing admixtures are acceptable; however, do not exceed the maximum water/cement ratio in order to achieve the required slump.

- If using a Type A, F, or G water reducer, then allowable slump shall be a maximum of 8 inches.

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Let's Review

- How many layers do we fill the slump cone in?
- How many times do we rod each layer?
- What is the maximum allowable time to complete the slump test?
- Measure slump to the nearest _____.

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4

Unit Weight (Density) and Yield of Concrete

AASHTO T 121

ASTM C 138

TDOT Standard Method of Test for

Unit Weight (Density) and Yield of Concrete

References

TDOT Standard Specifications
AASHTO T 121
ASTM C 138

Scope

- **Unit Weight: Mass per cubic foot of freshly-mixed concrete.**
- **Yield: Volume of concrete produced from a mixture of known quantities of component materials.**
- **Relative Yield: Ratio of actual volume of concrete obtained to the volume as designed for the batch.**

Equipment

- Balance
- Tamping rod
- Internal vibrator
- Strike-off plate
- Mallet
- Measure

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Capacity of Measure

Nominal Maximum Size of Coarse Aggregate (in.)	Capacity of Measure (ft^3)
1	0.2
1 ½	0.4
2	0.5

ASTM C138: Table 1

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Consolidation Method

- **Slump > 3 inches**

  Rodding

- **Slump < 1 inch**

  Vibration

- **Slump is between 1-3 inches**

  Rodding or Vibration

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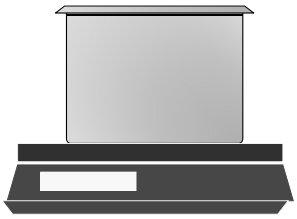
Procedure

- **Select a representative sample**

- **Determine the mass of the measure**



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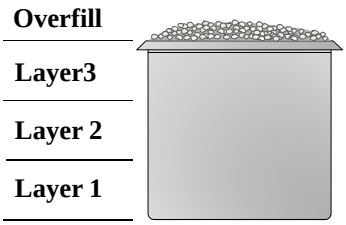
Procedure

- Fill the container in three equal layers
- Slightly overfill the last layer



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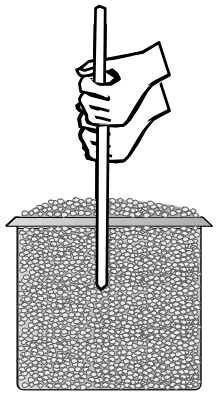
Procedure

- Rod each layer with 25 strokes of the tamping rod.
- Rod the bottom layer throughout its depth without forcibly striking the bottom of the container.
- Rod the middle and top layers penetrating about 1 inch into the underlying layer.
- Uniformly distribute the strokes over the cross-section of the layer.



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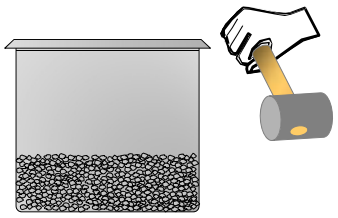
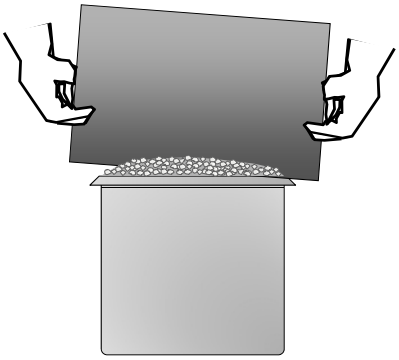
Procedure

- **Tap the sides of the container smartly 10-15 times with the mallet after rodding each layer.**



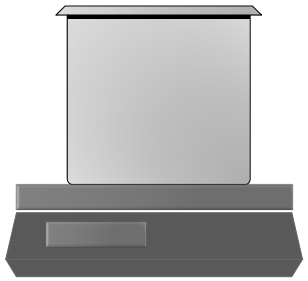
Procedure

- **Strike off the concrete level with the top of the container using a strike-off plate.**
- **Clean all excess concrete from exterior of measure.**



Procedure

- **Determine the mass of the concrete and measure.**



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Unit Weight Calculations

- **Unit Weight (D)**

$$M_{Concrete} = M_{Measure+Concrete} - M_{Measure}$$

$$D = \frac{M_{Concrete}}{V_{Measure}}$$

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Unit Weight Example

Determine the unit weight of concrete if:

volume of measure = 0.50 ft^3

mass of empty measure = 19.6 lb.

mass of measure and concrete = 92.1 lb.

Yield Calculations

- **Yield (Y)**

$$Y_{Concrete}(yd^3) = \frac{W_{material}}{27D}$$

Relative Yield Calculations

- **Relative Yield (R_y)**

$$R_y = \frac{Y}{Y_d}$$

If $R_y > 1.00$, an excess of concrete is being produced

If $R_y < 1.00$, the batch is "short" of its designed volume

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Yield/Relative Yield Example

Determine the yield and relative yield of the following mix:

Design batch	=	7 yd^3
Total mass of materials	=	27,300 lbs.
Unit weight of the concrete	=	145 lbs./ft^3

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Let's Review

- **Determine the unit weight, yield, and relative yield**
  - **Volume of measure = 0.25 ft³**
  - **Mass of empty measure = 7.5 lbs**
  - **Mass of measure and concrete = 43.2 lbs**
  - **Total mass of materials = 36000 lbs**
  - **Design batch = 9 yd³**

5

Air Content of Freshly Mixed Concrete

By the Pressure Method

AASHTO T 152

ASTM C 231

TDOT Standard Method of Test for

Air Content of Freshly Mixed Concrete by the Pressure Method

References

TDOT Standard Specifications
AASHTO T 152
ASTM C 231

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Summary of Test

- **Freshly-mixed concrete is sampled and compacted into a standard mold.**
- **The mold is covered, sealed and the remaining free space is filled with water.**
- **The contents are pressurized.**
- **The *air content* is shown on a dial.**

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Applicability

- **Applicable to concrete made with relatively *dense* aggregate particles**
- ***Not* applicable to *lightweight aggregate***

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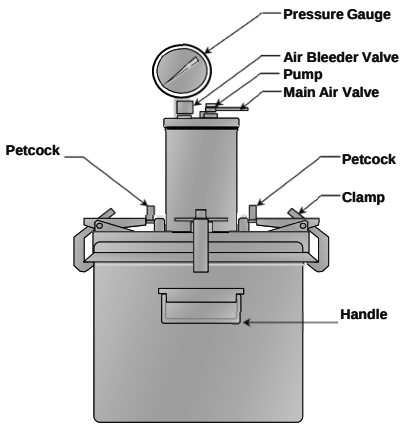
Equipment -Type B Meter



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Procedure

- Select a representative sample

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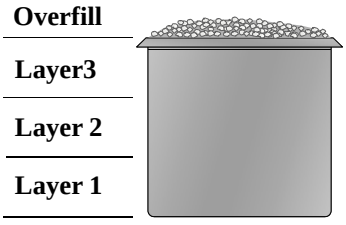
Procedure

- Fill the container in three equal layers
- Slightly overfill the last layer



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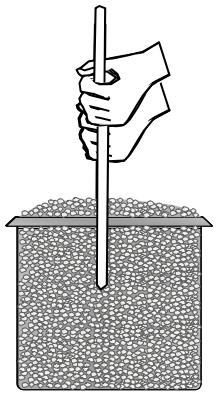
Procedure

- Rod each layer with 25 strokes of the tamping rod.
- Rod the bottom layer throughout its depth without forcibly striking the bottom of the container.
- Rod the middle and top layers penetrating about 1 inch into the underlying layer.
- Uniformly distribute the strokes over the cross-section of the layer.



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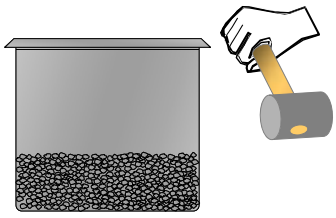
Procedure

- Tap the sides of the container smartly 10-15 times with the mallet after rodding each layer.



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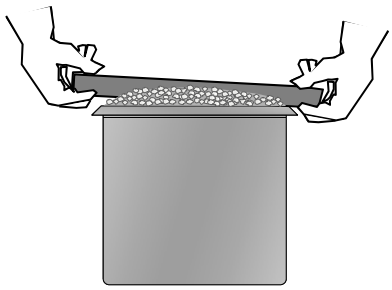
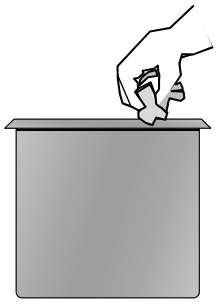
Procedure

- **Strike off the concrete level with the top of the container using the strike-off bar.**



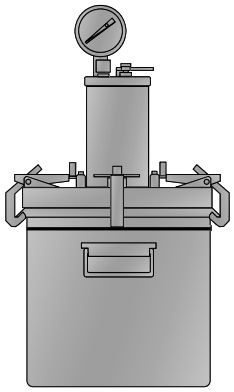
Procedure

- **Clean off the rim**



Procedure

- **Attach the top of the meter to the bottom**



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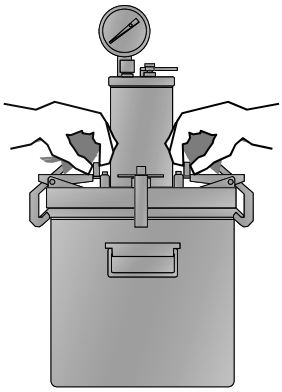
Procedure

- **Open both petcocks**



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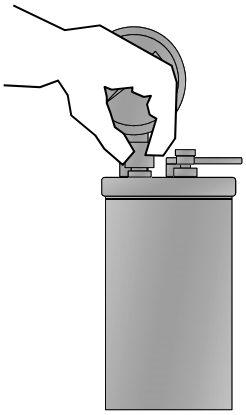
Procedure

- **Close the airbleeder valve**



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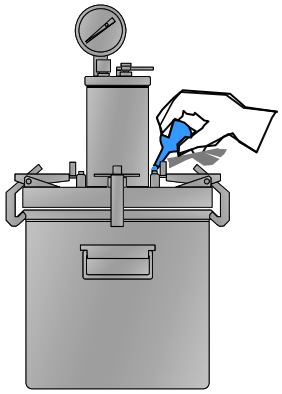
Procedure

- **Inject water through the petcock until it flows out of the other petcock.**



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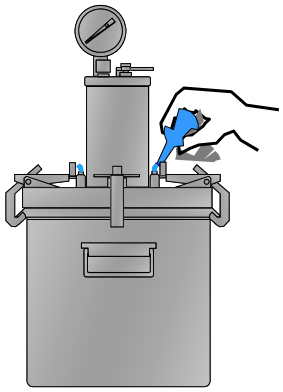
Procedure

- **Continue injecting water into the petcock while tapping the meter to insure that all of the air is expelled.**



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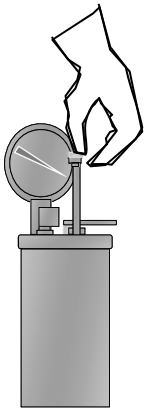
Procedure

- **Pump air up to the initial pressure line.**



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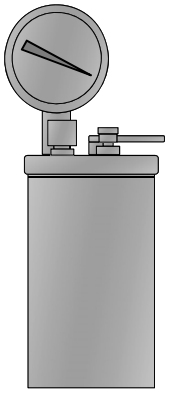
Procedure

- **Allow a few seconds for the compressed air to stabilize.**



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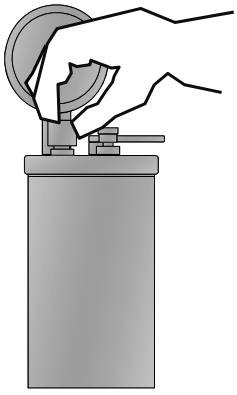
Procedure

- **Adjust the gauge to the initial pressure by _____ and _____ as necessary.**



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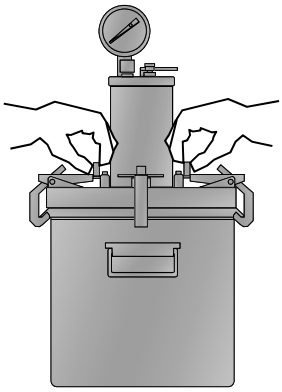
Procedure

- Close both petcocks

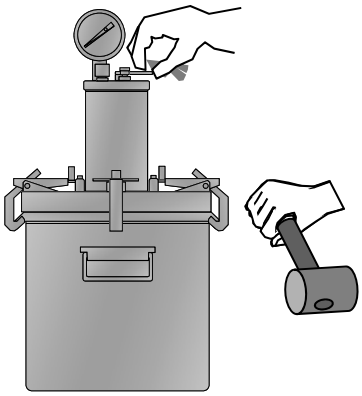


Procedure

- Open the air valve between the chamber and the bowl

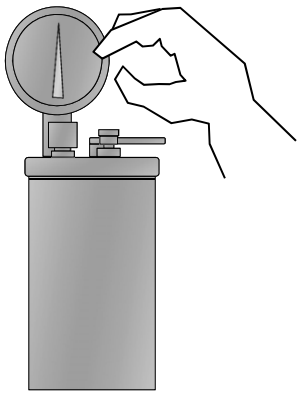
  And <u>simultaneously</u>

- Tap the sides of the bowl with the rubber mallet.



Procedure

- **Lightly tap the gauge to stabilize the needle.**
- **Read the percentage of air to the nearest 0.1%.**



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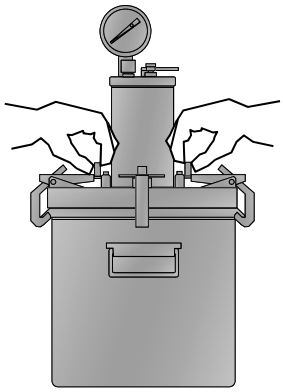
Procedure

- **Open both petcocks to release pressure**



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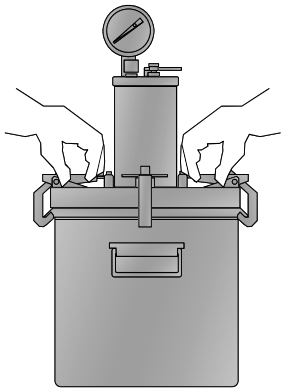
Procedure

- **Remove the cover**



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Example – Air Content (Pressure Method)

TN TDOT Department of Transportation

Table 604.03-01: Composition of Various Classes of Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)	Slump (inches)
A	3,000	564	0.45	6 ± 2	3 ± 1 (1)
D, DS (2, 3)	4,000	620	0.40	7 (3)	8 max (4)
L (3, 5)	4,000	620	0.40	7 (3)	8 max (4)
S (Seal) (6)	3,000	682	0.47	6 ± 2	6 ± 2
X (7)					

(3) **Design Class D, Class DS, and Class L concrete at 7% air content. Acceptance range for pumping and other methods of placement is 4.5-7.5%. Sampling will be at the truck chute.**

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Let's Review

- **Which type of concrete can this test NOT be used for?**
- **How many layers do we fill the measure in?**
- **How many times do we rod? Tap with the mallet?**
- **What tool do we use for strike-off?**
- **Record air to the nearest _____.**

Questions?

6

Air Content of Freshly Mixed Concrete

By the Volumetric Method

AASHTO T 196

ASTM C 173

TDOT Standard Method of Test for

Air Content of Freshly Mixed Concrete by the Volumetric Method

References

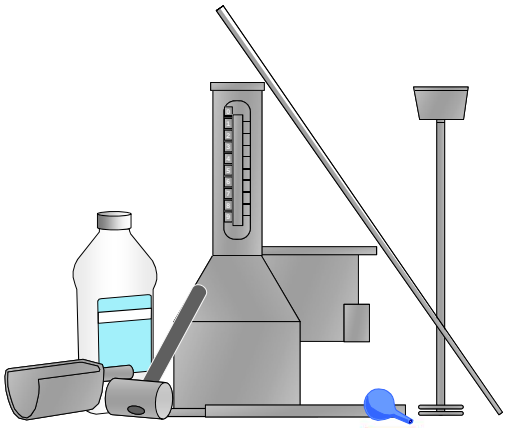
TDOT Standard Specifications
AASHTO T 196
ASTM C 173

Purpose

- **To determine the *air content* of freshly mixed concrete having dense or lightweight aggregate.**
- **To measure the air content in the mortar (paste) fraction of the concrete.**
- **Results are not affected by air that may be present within porous aggregate particles.**

Equipment

- Air Meter
- Tamping Rod- 16 inches long and 5/8 inches in diameter.
- Funnel
- Strike-Off Bar
- Calibrated Cup
- Syringe
- Pouring Vessel
- Scoop
- Isopropyl Alcohol
- Mallet

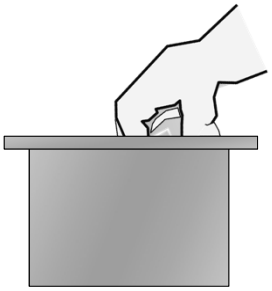


Procedure

- Obtain a sample of freshly-mixed concrete

Procedure

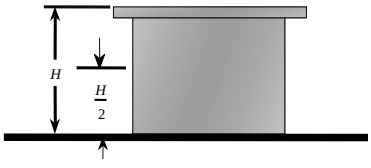
- **Dampen the inside of the bowl**



TN TDOT Department of Transportation

Procedure

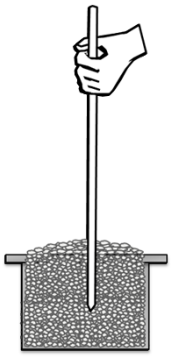
- **Fill the base/bowl with a sample of fresh concrete in 2 equal layers.**
- **Slightly overfill the last layer.**



TN TDOT Department of Transportation

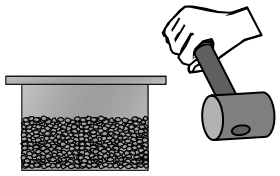
Procedure

- Rod each layer 25 times.
- Rod the bottom layer throughout its depth without forcibly striking the bottom of the base.
- Uniformly distribute the strokes over the cross-section of the each layer.
- Rod the top layer throughout its depth and penetrate about 1 inch into the first layer.



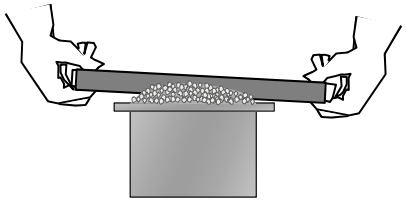
Procedure

- Tap the sides of the mold 10-15 times with the mallet after rodding the each layer.



Procedure

- **Strike off excess concrete on the top with a strike-off bar to level the top of the sample.**



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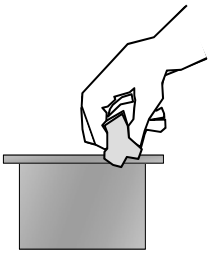
Procedure

- **Carefully clean the top edge of the flange and the gasket to provide a tight seal.**



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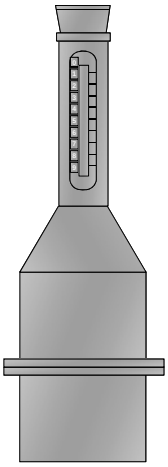
Procedure

- Clamp the top section into position on the base
- Insert the baffle bottom funnel
- Add at least 1 pint of water and the selected amount of alcohol
- Record the amount of alcohol added



Correction Factor

TABLE 1 Correction for the Effect of Isopropyl Alcohol on C173/C173M Air Meter Reading

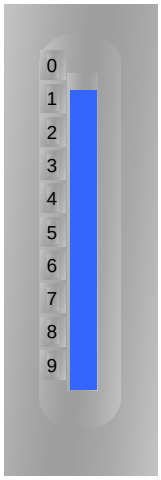
70 % Isopropyl Alcohol Used			
Pints	Fluid Ounces	Litres	Correction, %[A]
≤ 2.0	≤ 32	≤ 1.0	0.0[B]
3.0	48	1.5	0.25
4.0	64	2.0	0.50
5.0	80	2.5	0.75

[A] Subtract from final meter reading.

[B] Corrections are applied only when 1.25 L [2.5 pt] or more of isopropyl alcohol is used. The values given are for air meters that have a measuring bowl volume of 2.1 L [0.075 ft^3] and a top section that is 1.2 times the volume of the meauring bowl.

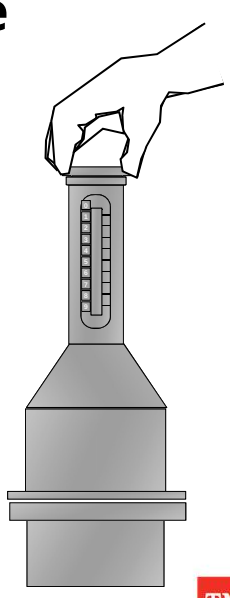
Procedure

- Add more water until it appears in the top section.
- When the water line begins approaching zero, remove funnel and add water using the rubber syringe until the bottom of the meniscus is level with the zero line.



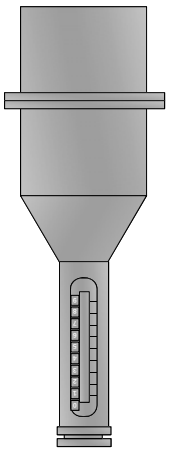
Procedure

- Attach and tighten the watertight cap.
- Note that the seal works by expanding, not twisting.



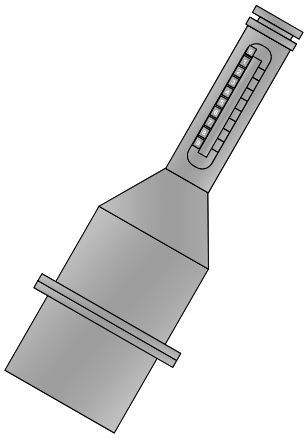
Procedure

- Quickly invert the meter, shake the base horizontally, and return the meter to the upright position.
- Do not keep the meter inverted for more than 5 seconds at a time.
- Repeat the inversion and shaking process a minimum of 45 seconds to free the concrete from the base.



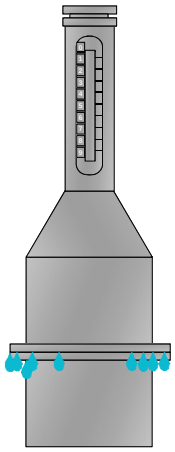
Procedure

- With one hand on the neck and the other on the flange, roll the meter along the floor for approximately 1 minute.
  - Roll the meter ¼ to ½ turn back and forth.
  - Turn the bowl 1/3 turn and repeat the rolling process.



Procedure

- **If the air meter leaks while inverting or rolling, start a new test on a new sample.**



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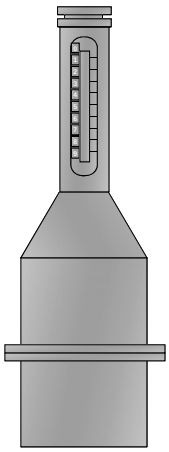
Procedure

- **Set the unit upright**
- **Loosen the cap to allow any pressure to stabilize.**
- **Allow the meter to stand until the liquid level stabilizes.**
- **It is considered stable when it does not change more than 0.25% air within a 2-minute period.**



TN TDOT Department of Transportation

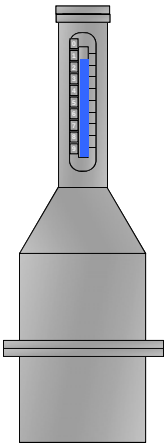
Procedure

- If it takes more than 6 minutes for the liquid level to stabilize

or

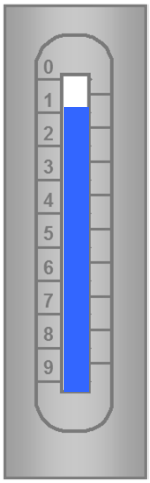
- If there is more foam than that equivalent to 2% air on the meter scale over the liquid level.

- **Discard the trial and start a new test.** Use a larger addition of alcohol than was used in the initial trial.



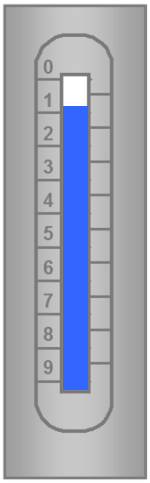
Procedure

- When finished rolling once,
  - Read the liquid level to the nearest 0.25%
  - Record the initial meter reading
  - Retighten the cap and repeat the rolling procedure



Procedure

- When finished rolling twice,
  - Read the liquid level to the nearest 0.25%
  - If the second reading changed from the initial reading by more than 0.25% use the second reading as the new initial reading
  - Otherwise, use the second reading as the final reading



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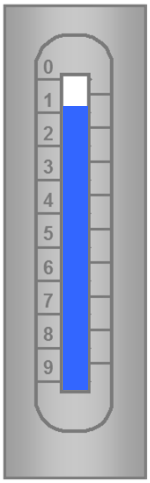
Procedure

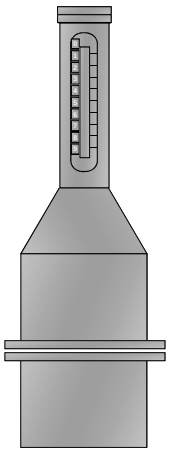
- When finished rolling three times,
  - Read the liquid level to the nearest 0.25%
  - If the third reading changed from the initial reading by more than 0.25%, discard the sample and start a new test with a greater amount of alcohol.
  - Otherwise, use the third reading as the final reading



TN TDOT Department of Transportation

Procedure

- Disassemble the unit
- Examine the contents
- If portions of undisturbed concrete are found, the test is <u>invalid.</u>
- If no undisturbed portions are found, the test is <u>valid</u>.



Procedure

- Only if the air content is greater than the 9% range of the meter, add a sufficient number of calibrated cups of water to bring the liquid level within the graduate range.
- Read the bottom of the meniscus to the nearest 0.25%.
- Record the number of cups of water added. This number will to be *added* to the final meter reading when testing is complete.

Calculations

- $A = A_R - C + W$

  A = Air Content, %

  A_R = Final meter reading, %

  C = Correction Factor

  W = Number of calibrated cups added to the meter

Example - Air Content Volumetric Method

Table 604.03-01: Composition of Various Classes of Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)	Slump (inches)
A	3,000	564	0.45	6 ± 2	3 ± 1 (1)
D, DS (2, 3)	4,000	620	0.40	7 (3)	8 max (4)
L (3, 5)	4,000	620	0.40	7 (3)	8 max (4)
S (Seal) (6)	3,000	682	0.47	6 ± 2	6 ± 2
X (7)					

(3) Design Class D, Class DS, and Class L concrete at 7% air content. Acceptance range for pumping and other methods of placement is 4.5-7.5%. Sampling will be at the truck chute.

(5) The unit weight of air dried Class L concrete (lightweight concrete) shall not exceed 115 pounds per cubic foot as determined according to ASTM C567.

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Let's Review

- Which type of concrete can this test be used for?
- Invert and shake the meter for a minimum of _____.
- How long do we roll the meter?
- Record air to the nearest _____.
- What would constitute repeating the test?

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7

Making and Curing Concrete Test Specimens in the Field

AASHTO T 23

ASTM C 31

TDOT Standard Method of Test for

Making and Curing Concrete Test Specimens in the Field

References

TDOT Standard Specifications
AASHTO T 23
ASTM C 31

Purpose & Applicability

- **Concrete specimens used for testing strength must be made by this method to ensure reliability of test results.**
- **Standardized requirements for making, curing, protecting, and transporting concrete tests specimen under field conditions.**

Equipment

- Molds
- Scoop
- Tamping rod
- Vibrators
- Mallet
- Capping Material

Equipment

TABLE 1 Tamping Rod Diameter Requirements

Diameter of Cylinder or Width of Beam in. [mm]	Diameter or Rod in. [mm]
<6 [150]	⅜ ± 1/16 [10 ± 2]
≥6 [150]	⅝ ± 1/16 [16 ± 2]

Procedure

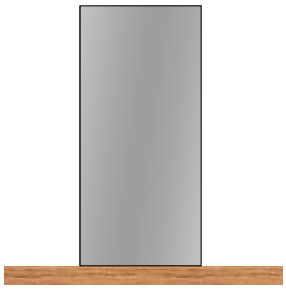
- **Select a representative sample**

Consolidation

- **Slump > 1” Rod or Vibration**
- **Slump ≤ 1” Vibration**

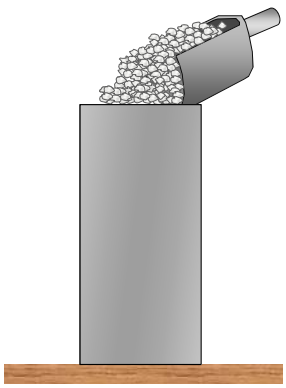
Procedure

- **Place the mold on a level, horizontal, rigid surface that is free of vibration.**



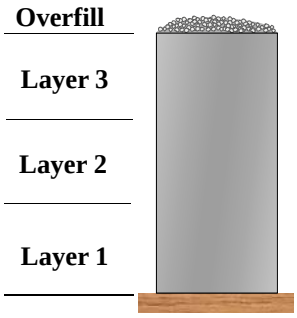
Procedure

- **Place the concrete in the mold using a scoop.**
- **Move the scoop around the top edge of the mold to evenly distribute the concrete.**



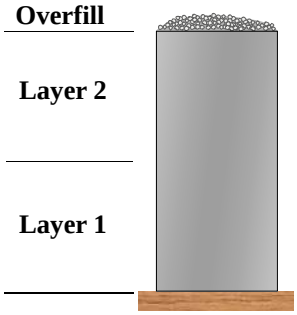
Procedure - 6x12 Cylinders

- Class CP only
- Fill the mold in three equal layers
- Slightly overfill the last layer
- Rod each layer with 25 strokes of the tamping rod.
- Tap the sides of the mold 10-15 times with the mallet after rodding each layer.



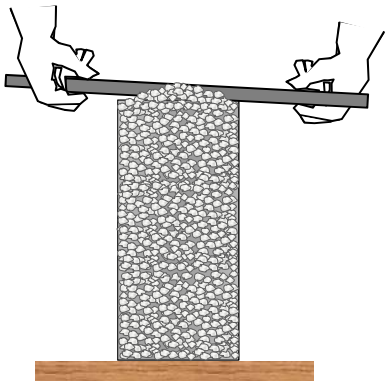
Procedure - 4x8 Cylinders

- Fill the mold in two equal layers
- Slightly overfill the last layer
- Rod each layer with 25 strokes of the tamping rod.
- Tap the sides of the mold 10-15 times with the mallet after rodding each layer.



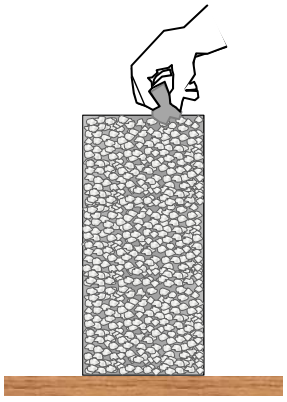
Procedure

- **Strike off the concrete level with the top of the mold using the tamping rod.**



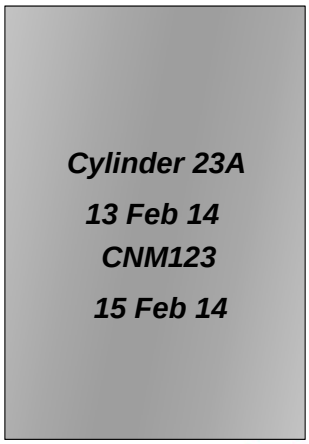
Procedure

- **Clean off the rim**



Procedure

- Mark the specimen with positive identification
- Do not mark on removable caps
- <u>Do not etch on the top surface.</u>
- Mark the side of the cylinder with the following:
  - Cylinder #
  - Date Made
  - Contract #
  - Date Stripped



Procedure

<u>Finishing</u>

- Produce a flat even surface that is level with the rim or edge of the mold.
- No depressions or projections larger than 1/8 in.

Procedure

Storage

Immediately after finishing move specimens to initial curing place for storage.

- **Supporting surface should be level to within ¼ in. per ft.**
- **Lift and support the cylinder from the bottom of the molds.**

Procedure

- **Use an appropriate method of maintaining required moisture and temperature conditions.**

Procedure

Initial Curing

- **Immediately after molding and finishing, store specimens for a period up to 48 hrs in a temperature ranging from 60 and 80ºF.**
- **High early strength cylinders(>6000 psi) shall have initial curing temperature between 68 and 78ºF.**
- **Storage temperature shall be controlled by use of heating and cooling devices, as necessary.**

Procedure

Final Curing

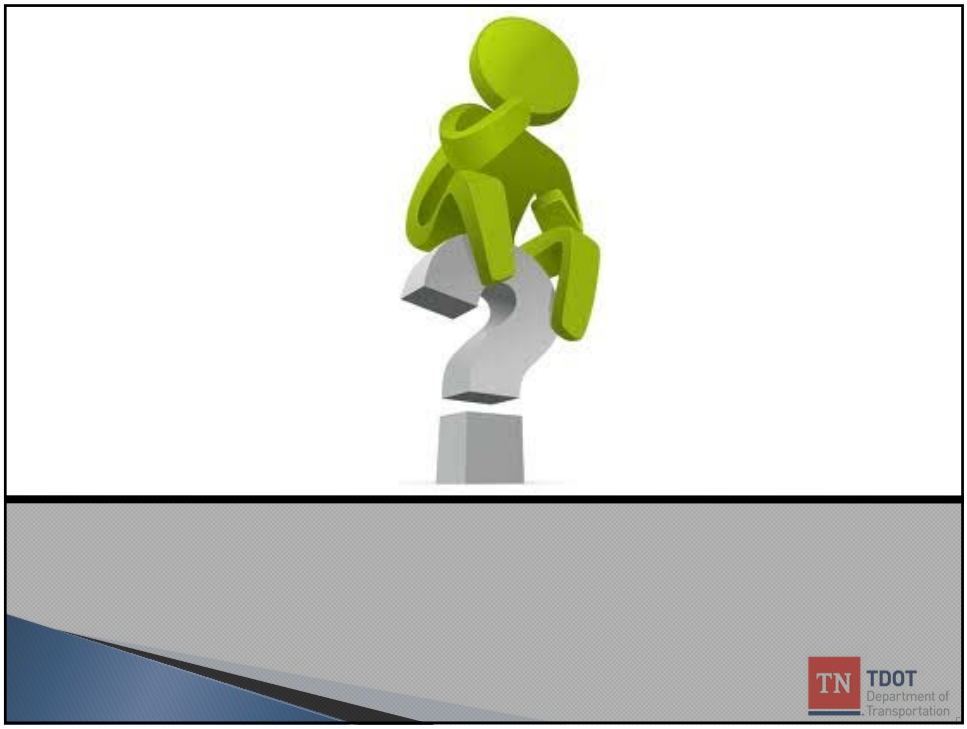
- **Within 30 min. after removing molds, cure specimens with free water maintained on surface at all times at temperature of 73.5± 3.5ºF.**

Transportation

- **Specimens shall not be transported until at least 8 hours after final set.**
- **Transportation time shall not exceed 4 hrs.**
- **Protect specimens from damage by using suitable cushioning material**
- **Prevent moisture loss**

Let's Review

- **How many layers do we fill 6x12 cylinders in? 4x8s?**
- **What size diameter tamping rod is required for making 6x12 cylinders? 4x8s?**
- **How level should the supporting surface be when storing cylinders?**
- **What is the initial curing temperature required for high early strength cylinders?**
- **What is the maximum time allowed to transport cylinders?**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8

Self-Consolidating Concrete

(SCC)

ASTM C 1611

ASTM C 1621

ASTM C 1758

TDOT Standard Method of Test for
Self-Consolidating Concrete

References

TDOT Standard Specifications
ASTM C 1611
ASTM C 1621
ASTM C 1758

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Self-Consolidating Concrete (SCC)

- *"Self-consolidating concrete (SCC) is highly flowable, **non-segregating** concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation."*

  (ACI 237R-07)

- U-Box Demo
- Foundation Pour

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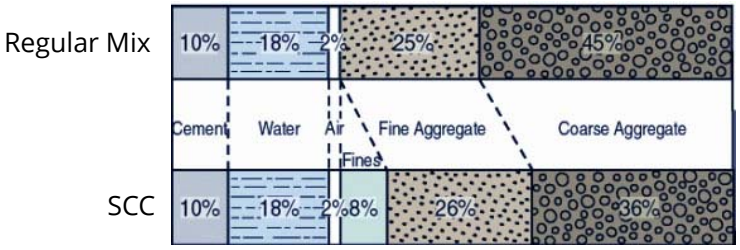
What Is SCC?

It is a conventional concrete mix with modified proportions that may use specialized chemical admixtures.



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Usage

SCC is great for filling in unusual shapes, passing through dense reinforcement, or filling in tight spaces in formwork.

Its highly flowable consistency means that it does **not** need external consolidation of any kind (vibration).

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Usage

Increasingly popular implementation of SCC:

- Precast Production
- Prestressed Bridge Girders (where narrow forms and congested reinforcement make proper filling and consolidation using conventional concrete difficult and labor-intensive)

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Precast/Prestressed

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Dense Reinforcement

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Advantages

- Reduce labor and equipment
- No vibration needed
- Flows to fill space = less placement points
- Enables placements with very dense reinforcement
- Less people to manage = safer jobsite
- Smooth surfaces free of honeycombing

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Disadvantages

- Concrete unit cost
- Significantly increased formwork pressure
- Formwork joints must be more tightly sealed
- Higher quality control needed at batch plant due to complex admixture interactions.

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Terminology and Properties

- **Workability** describes the ease with which concrete can be mixed, placed, consolidated, and finished.
- Workability of SCC is described in terms of
  - **filling ability**
  - **passing ability**
  - **stability**

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Terminology and Properties

- **Filling ability** describes the ability of SCC to flow into and fill completely all spaces within the formwork, under its own weight.
- **Passing ability** refers to the ease with which concrete can pass among various obstacles and narrow spacing in the formwork without blockage.

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Terminology and Properties

- **Stability** of concrete describes the ability of a material to maintain homogeneous distribution of its various constituents during its flow and setting.
- There are two types of stability characteristics that are important for SCC
  - **dynamic stability**
  - **static stability**

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Terminology and Properties

- **Dynamic stability** refers to the resistance of concrete to the separation of constituents during placement into the formwork.
- **Static stability** refers to the resistance of concrete to bleeding, segregation, and surface settlement after casting while the concrete is still in a plastic state.

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Properties

- Generally speaking, stability and filling/passing ability are inversely proportional.
- The greater the filling/passing ability, the harder it is to get a very stable mixture.
- The greater the stability, the harder it is to get greater filling/passing ability.
- The degrees of stability, filling ability, and passing ability of SCC are dictated by the application.

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Reinforcement Challenges

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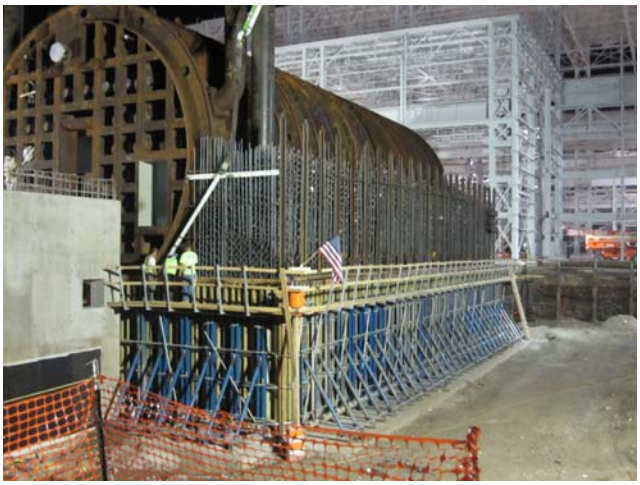
Concrete Placement



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Field Experience

- SCC is much more sensitive to additional water on jobsite than conventional concrete.
- Form pressures are elevated with SCC. Contractors performing SCC work are strongly encouraged to consult with their forms manufacturer for best practices.

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Field Experience has taught…

- Correct aggregate moisture is important since SCC is very sensitive to changes in mix water.
- New High Range Water Reducers (HRWR) perform better when added at plant during initial mixing.
- Use Water Reducers for additional slump flow requirements at the project site instead of water.

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Testing Methods

- **ASTM C 1611**: Slump Flow of SCC
  - Slump Flow
  - VSI (Visual Stability Index)
  - T-50
- **ASTM C 1621**: Passing Ability of SCC by J-Ring
- **ASTM C 1758**: Fabricating Test Specimens with SCC

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ASTM C1611
Slump Flow, T50, & VSI

- Two procedures:
  - Slump cone upright

  - Slump cone inverted

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Apparatus

- **Mold** – Conform to that described in ASTM C143
- **Base Plate** – Nonabsorbent, smooth, rigid with a minimum diameter of 36 inches
  - For T-50, inscribed with concentric circles for the slump cone and one with a 20 inch diameter.
- **Strike-off bar** – Described in ASTM C173
- **Stopwatch** – 0.01 second precision
- **Pouring Vessel** - A water-tight container having a volume such that concrete is not spilled during placement in the specimen container.

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Slump Flow and T-50

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Slump Flow

- The slump flow test is a measure of mixture filling ability.
- The test is similar to the conventional slump test using the same standard slump cone.
- Instead of measuring the slumping distance vertically, the average spread of the resulting concrete patty is measured horizontally.

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Procedure

1. Select a flat, level, nonabsorbent surface.
2. Dampen the mold and place it in the center of the base plate.
3. Immediately fill the mold in one lift.
   - Position the pouring vessel no more than 5 inches above the top of the container
   - Ensure an even distribution of concrete, without rodding the concrete or tapping the sides of the container, while filling the container

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Procedure (continued)

4. If necessary, repeat step 3 until the container is filled slightly above its rim
5. Strike off the surface of the concrete using a strike off bar level with the top of the mold.
6. Remove the concrete from around the base of the mold.
7. Lift the mold vertically to 9 ± 3 inches in 3 ± 1 seconds with no lateral or torsional motion.

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Procedure (continued)

8. Wait for the concrete to stop flowing, measure the largest diameter of the spread of concrete to the nearest 0.25 inch. If a halo is present, include with measurement.
9. Measure a second diameter approximately perpendicular to the first.

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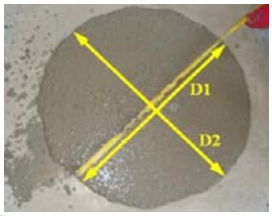
Procedure (continued)

10. If the two diameters are more that 2 inches different, the test shall be repeated.
11. Average the two spread diameters and record the slump flow to the nearest 0.50 inch.

https://www.youtube.com/watch?v=Gm9Adz5EPE4



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Example Problems

Example Problem#1

- **Given:** Spread Diameter (1) = 22 inches
  Spread Diameter (2) = 21.25 inches
- **Determine the slump flow.**

Slump Flow = [d(1)+d(2)]/2
= [22+21.25]/2
= 43.25/2
=21.625 ⇒ 21.50 inches

Example Problem#2

- **Given:** Spread Diameter (1) = 22.75 inches
  Spread Diameter (2) = 20.25 inches
- **Determine the slump flow.**

Slump Flow = [d(1)+d(2)]/2
= [22.75+20.25]/2
= 43.00/2
=21.50 inches
WRONG ⇒ REPEAT
(Diameters differ more than 2 inches)

The reported slump flow is the average of the two diameters reported to the nearest 0.5 inches.

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T-50 Procedure

- The T-50 is measured when the slump flow is being performed.
- To determine T-50,
  - Use a stopwatch to measure the time (in seconds)
  - Time it takes any part of the outer edge of the spreading concrete to reach the inscribed mark on the base plate from the time the mold is first lifted
- Record the T-50 to the nearest 0.2 seconds.

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Visual Stability Index

After the Slump Flow test is performed, the visual stability index (VSI) is determined through rating the apparent stability of the slump flow patty.

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Terminology

- **Halo**: An observed cement paste or mortar ring around the outside circumference of the slump flow patty.
- **Spread**: The distance of lateral flow of concrete during the slump-flow test.
- **Stability**: The ability of a concrete mixture to resist segregation of the paste from the aggregates.

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Visual Stability Index (VSI)

- Using the patty from a slump flow test, inspect the patty's perimeter. **Is there a definite mortar halo?** If so, how wide is the halo?
- Inspect the surface of the patty. **Is there sheen on the surface (excess water)?**
  - Bleed water will cause a sheen on the surface or cause puddles on top of the patty.
- Assess the aggregate distribution in the patty. **Did the aggregate spread with the mortar or is there an aggregate pile in the center of the patty?**
- **Assign a VSI value to the SCC patty.**
- Refer to the following table and example pictures.

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Visual Stability Index (VSI)

TABLE X1.1 Visual Stability Index Values

VSI Value	Criteria
0 = Highly Stable	No evidence of segregation or bleeding.
1 = Stable	No evidence of segregation and slight bleeding observed as a sheen on the concrete mass.
2 = Unstable	A slight mortar halo ≤ 0.5 in.(≤ 10 mm) and/or aggregate pile in the of the concrete mass.
3 = Highly Unstable	Clearly segregating by evidence of a large mortar halo > 0.5 in. (> 10 mm) and/or a large aggregate pile in the center of the concrete mass.

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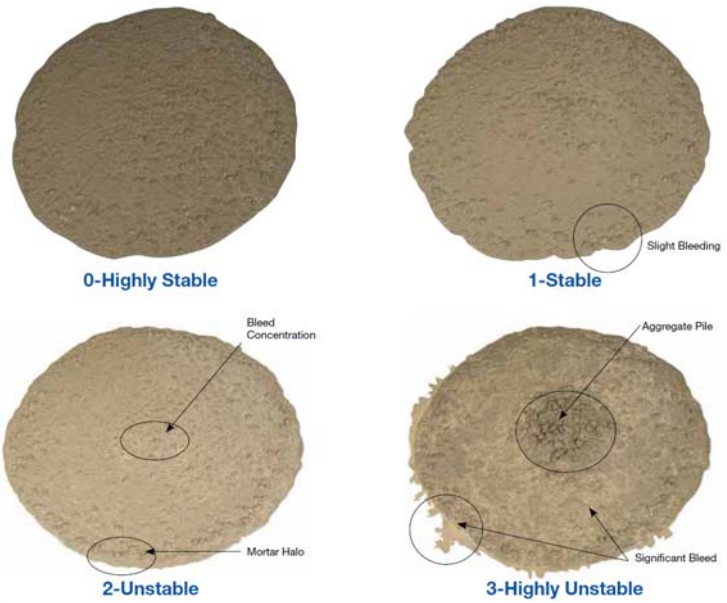

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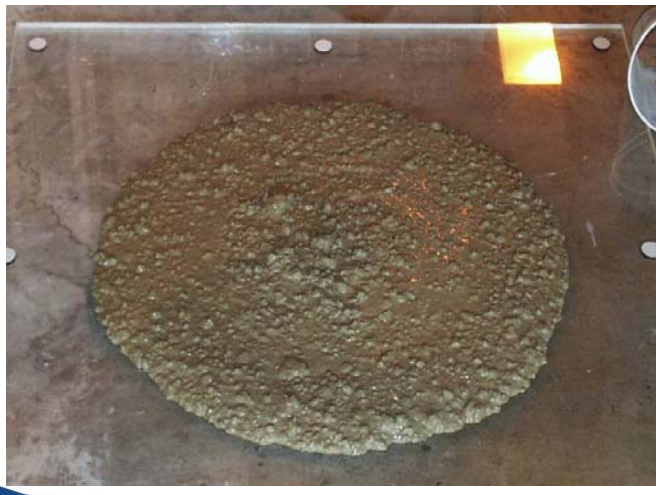
VSI = 0



- No mortar halo
- No puddles of water

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VSI = 1

Slight sheen on the concrete

False mortar halo caused by excess water on the base plate

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VSI = 1

Slight water sheen observed

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VSI = 2

Water puddle in concrete patty

Very glossy surface

Mortar halo 0.25” ≤ 0.5”

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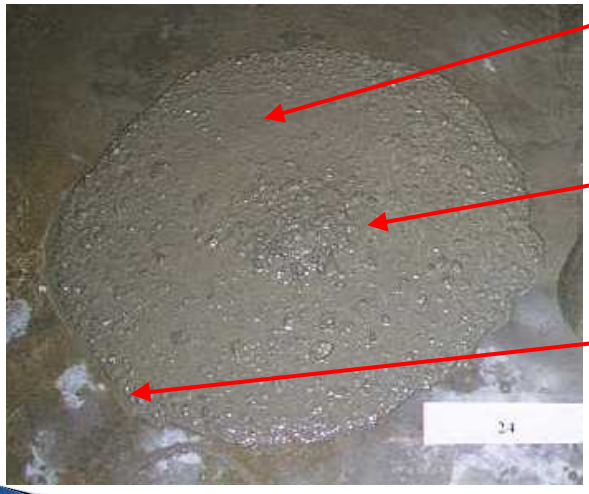
VSI = 2



Water puddles on concrete patty

Aggregate pile near the center of patty

Mortar halo 0.25” ≤ 0.5”

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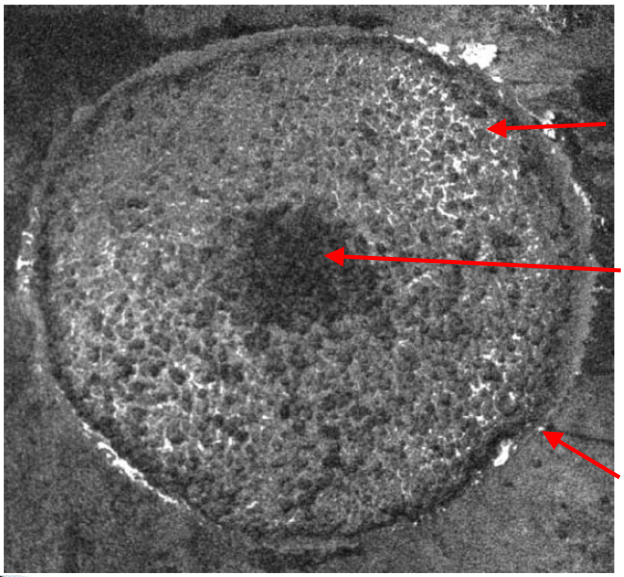
VSI = 3



Water puddles in patty

Aggregate pile near the center of patty

Mortar halo greater than 0.5 in.

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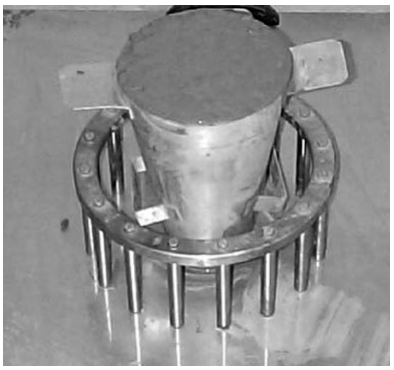
ASTM C1621
Passing Ability by J-Ring



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Procedure

1. A sample of freshly mixed concrete is placed in one lift without tamping or vibration in a mold that is concentric with the J-Ring.
2. The mold is raised, and the concrete is allowed to spread through the J-Ring.
3. After spreading ceases, two diameters of the concrete are measured in approximately diagonal directions.
4. J-Ring flow is the average of the two diameters.
5. Passing Ability = Slump Flow – J Ring Flow
6. Complete slump flow and J-Ring tests within 6 min.

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Example Problems

Example Problem#1

- **Given:** Slump Flow = 23.50 inches
  J-Ring Flow = 21.00 inches
  VSI = 1
- **Determine the passing ability.**

Passing Ability = Slump Flow - J-Ring Flow

= 23.50 - 21

= 2.50 → 2.50 inches

Poor Passing Ability

Example Problem#2

- **Given:** Slump Flow = 22.5 inches
  J-Ring Flow = 22.0 inches
  VSI = 0
- **Determine the passing ability.**

Passing Ability Slump Flow - J-Ring Flow

= 22.5 – 22.0

= 0.50 inches

Good Passing Ability

Report the passing ability to the nearest 0.5 inches

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ASTM C1758
Unit Weight, Air Content, and Cylinders

- Applicable for SCC having a slump flow of 20 inches or greater.
- Molds, measures, and containers used for unit weight, air content, and making cylinders shall conform to conventional concrete requirements.
- Testing procedures are the same as for conventional concrete with the exception of filling
  - Fill in one lift
  - No rodding
  - No tapping

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Supplemental Specifications Subsection 604.03.1b

- Fine aggregate ≤ 50% by volume of total aggregate (normally ≤ 44%)
- Maximum coarse aggregate size No. 67 stone
- SCC may be used as alternate for Class A concrete

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Supplemental Specifications Subsection 604.03.1b

Table 604.03-4: Composition of Self-Consolidating Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design + production tolerance)	Slump Flow (inches)
SCC (2,3,4,5)	3,000(1)	564	0.45	6 ±2	26±5
SH-SCC (2,3,4,5,6)	4,500	620	0.45	6 ±2	26±5

(1) Or as shown on the Plans or approved shop drawings.

(2) Acceptance range for the T50 test in accordance with ASTM C1611 shall be between 2-7 seconds

(3) Passing ability in accordance with ASTM C1621 shall be less than 2 inches for acceptance.

(4) Visual Stability Index (VSI) shall not exceed 1.0 as per ASTM C1611 for acceptance.

(5) Static segregation as measured by ASTM C 1610 shall not exceed 20%.

(6) Air Content may be reduced if placed under water or underground if approved by the Engineer

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Supplemental Specifications Subsection 604.03.2

- Verify self-consolidating concrete (Classes SCC and P-SCC) prior to placement at ready mix facility or prestressed plant
- Mix design reviewed by HQ M&T
- Trial Batch verification by producer with Regional M&T present
- Trial batch not required if using a previously approved SCC design

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Let's Review

- **Record T-50 to the nearest _____.**
- **Measure spread diameters to the nearest _____. Average these measurements to the nearest _____.**
- **How do we calculate passing ability?**
- **When using SCC, how many lifts are required?**
- **What does the J-Ring represent?**

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Questions?

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Appendix

Appendix

Notable Specifications

- 501.10
  - Total revolutions at mix speed
  - Haul times
- 604.13
  - Total amount of water in mix
  - Haul times

Notables

- Concrete Delivery Ticket Information
- Concrete Cylinder Report
- SOP 1-1
- SOP 4-1
- SiteManager Guides

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Operations Memos

- Concrete Cylinder Acceptance
  - Date: November 16, 2016
  - Subject: Number of Cylinders
- Concrete Cylinder Acceptance
  - Date: November 14, 2017
  - Subject: Making, curing, handling of cylinders

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Circular Letters

- C.L. 604.03-01
  - Date: April 1, 2009
  - Subject: Concrete Delivery Tickets
- C.L. 501.09-01
  - Date: July 1, 1992
  - Subject: Concrete Batch Tickets

Notable Specifications

501.10 - Total revolutions at mixing speed - 70 to 100 for drum mixers

604.13 – If water, air entrainers, or chemical admixtures are added at the placement site, mix the concrete a minimum of 30 revolutions at mixing speed after making the additions.

604.13 – Water added at the placement site for Class A, D, and L concrete shall not exceed 1 gallon per cubic yard.

604.13 – Total amount of water in the mix shall not exceed the maximum in the approved mix design. (Cannot add water after the acceptance tests have been performed)

Haul times

501.10 - Non-agitating trucks: No more than 30 minutes shall elapse from the time water is added to the mix

501.10 – Truck Mixers or Truck Agitators: No more than 60 minutes shall elapse from the time water is added to the mix.

604.13 – Truck Mixers: No more than 90 minutes shall elapse from when the water is added to the mix until the concrete is deposited in place.

604.13 – When the temperature exceeds 90˚F, no more than 60 minutes shall elapse for concrete placed in bridge decks.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TN 37243

CONCRETE DELIVERY TICKET

Date: _____ Ticket # _____

Contract # _____ County _____ Region _____ Load # _____

Project # _____ Proj. Ref. # _____

Conc. Design # _____ Concrete Class: _____ No. Cubic Yards: _____ Actual W/C : _____

		ACTUAL	TARGET[3]	TOLERANCE
CEMENT	**lbs.**			
FLYASH	**F☐C☐ lbs.**			
SLAG	**lbs.**			
ROCK	**lbs.**			
SAND	**lbs.**			
WATER	**gal.**			

		ACTUAL	TARGET
A.E.A.	**oz.**		
W.R.A.	**oz.**		
WATER	**oz.**		
MISC.	**oz.**		

Will accept computer generated equivalent

Max. water allowed[1] (Actual) _____ Gallons

Total water [2](Plant) _____ Gallons

Max. water allowed (Project) _____ Gallons

Water added (Project) _____ Gallons

No. Rev. @ Mixing Speed (Plant) _____

No. Rev. @ Mixing Speed (Project) _____

Time loaded: _____ Time discharged: _____

Truck No. _____ Loc. Sta. _____

_____
(Unit of Structure)

_____ _____ _____
Print Name (Plant Tech) Plant Tech Cert. No. Plant Tech. Signature

_____ _____ _____
Print Name (Inspector at delivery point) Field Tech Cert. No. (TDOT Rep.) Inspector Signature

1 Based on actual cementious material allowed by design

2 Actual used at plant

3 May be adjusted to meet specification requirements.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

CONCRETE CYLINDER/CORE TEST REPORT

Information to be completed by TDOT personnel for acceptance/assurance testing & cylinders/cores

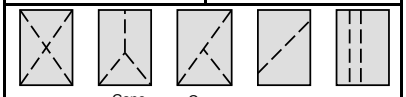
Reference No. _____ County _____ Region _____
Project No. _____ Contract No. _____ Date _____
Contractor Placing Concrete _____ Volume Poured this Date (m^3, yd^3) _____
Daily Report No. _____ Date of Pour _____ Requested Age of Test _____
Concrete Producer _____ Location _____
Cyl./Core Numbers _____ Volume Represented by Cyls/Cores (m^3, yd^3) _____
Design Number _____ Design Strength _____ Concrete Class _____
TDOT Supervisor _____ Date Placed in Wet Curing Environment _____

Item Number					
Pay Quantity/Unit					
Quantity Delivered					
Sta. of Cyl./Core					

Description of Pour(s):	
Remarks:	

Laboratory Test Data *(ASTM C-39, C-511, and C1231)*

Cylinder No. / Core No.		
Serial No.		
Date Received		
Date Tested		
Date Reported		
Diameter (in)		
Cross-sectional Area (in²)		
Maximum Load (lbf)		
Compressive Strength (psi)		
Ave. Compressive Strength (psi)		
Type of Fracture		
Performed by		
Technician Certification No.		



Field Test Data

Slump, in. *(ASTM C-143)*	
Air Temp., °F	
Concrete Temp., °F *(ASTM C-1064)*	
% Air *(ASTM C-173, Volumetric)*	
% Air (ASTM C-231 Pressure)	
Unit Weight (lbs/ft³) *(ASTM C-138)*	
Performed by/ Cert. No.	
Contractor Observer/Cert. No.	

FOR TDOT LAB USE ONLY ASTM C-39, every ten cylinders

DIA: + =

DIV BY 2 = AVERAGE =

CONDITION OF CYLINDER: GOOD FAIR POOR

COMMENTS:

All cylinders will be capped & conditioned using ASTM C-1231 unless >10000 PSI

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor

Approved by _____
Director of Materials and Tests

Date _____

Contractor: Received by _____ Date _____ SM Sample ID _____

Form DT-0062 (Rev. 12-17)

PART TWO: ACCEPTANCE SAMPLES AND TESTS

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Portland Cement Concrete (Except Prestressed, Precast, Pavement and Base)	Cement, Fly Ash, and GGBFS	Acceptance from Qualified Products List (Verification Sampling Required)				Must be from approved source; if not, must have complete lab tests before being used on project.
	Curing Compound	Acceptance from Qualified Products List (Verification Sampling Required)				A compatible Type 1-D, Class B membrane shall be used when texture coating is specified.
	Chemical Admixtures	Acceptance from Qualified Products List				Admixture must be on approved list and have the brand shown on concrete design. Check dosage amounts for compliance with concrete design.
	Aggregate: Coarse and Fine	Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material.
	Reinforcing Steel (Bars)	Acceptance by Certification (Verification Sampling Required)				See attached Verification Check Samples and Tests section.
	Completed Concrete Mix	Cylinders (28-day) Slump, Air Content, Mix Temperature *All early break cylinders shall conform to the requirements as stated in Part 1 of the SOP Guide.	Project Inspector	*A complete set of tests and pair of cylinders for each 100 yd^3 placed per critical unit of structure. For Class D or L, One complete set of tests for each of the first three loads. One pair of cylinders shall be cast from one of the first three passing loads; additional tests and pairs of cylinders to be made for each additional 50 yd^3	Randomly selected during placement	Determine Slump and Air Content from the same sample of concrete that cylinders are made from. For Class D or L, Bridge Deck Concrete per SOP 4-1; concrete placed by pumping shall be checked for air content at the discharge end of the truck chute immediately prior to pumping. ***Complete set of tests shall be performed on the initial load for quality control/informational purposes, not for acceptance.** The volumes of noncritical items may be combined when utilizing the same ready mix plant.
Portland Cement Concrete Non-Critical Structures for **Small Quantities (Not to exceed 25 yd^3 per week per project for combined concrete items.)**	Cement and Fly Ash GGBFS	Acceptance from Qualified Products List (Verification sampling required)				Must be from approved source; if not, must have complete lab tests before being used on project.
	Curing Compound	Acceptance from Qualified Products List (Verification sampling required)				A compatible Type 1-D, Class B membrane shall be used when texture coating is specified.
	Chemical Admixtures	Acceptance from Qualified Products List				Admixture must be on approved list and have the brand shown on concrete design. Check dosage amounts for compliance with concrete design.
	Aggregate: Coarse and Fine	Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material
	Reinforcing Steel (Bars)	Acceptance by Certification (Verification Sampling Required)				
	Completed Concrete Mix	Visual Inspection, Cylinders, (28 day) Slump, Air Content, Mix Temperature *All early break cylinders shall conform to the requirements as stated in Part 1 of the SOP Guide.	Project Inspector	*Complete set of tests and pair of cylinders for pours of 25 yd^3 or less weekly. If over 25 yd^3 per week is poured then follow procedures outlined in Portland Cement Concrete (Except Prestressed, Precast, Pavement and Base). Delivery tickets must accompany each load & contain batch weights, class of concrete & time of batching.	Randomly selected at placement site	NOT TO BE USED IN MAJOR STRUCTURES OR STRUCTURALLY CRITICAL ITEMS. ONLY FOR: Sidewalks, Curbs & Gutter, Building Foundations, Slope Paving, Ditch Paving, Guardrail Anchorage, Small Culvert Headwalls (30" or less), Fence Posts, Catch Basins, Manhole Bases & Inlets, and Small Sign Bases. ***Complete set of tests shall be performed on the initial load for quality control/informational purposes, not for acceptance.**
	Pre-approved Pre-packaged Concrete Mixtures	Acceptance from Qualified Products List				To be limited to 2 yd^3 per day for items as listed above.

Part Two: Acceptance Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Portland Cement Concrete - Pavement & Base	Cement, Fly Ash, and GGBFS	Acceptance from Qualified Products List (Verification sampling required)				Must be from approved source or have complete lab analysis and approved before being used.
	Curing Compound	Acceptance from Qualified Products List (Verification sampling required)				A compatible Type 1-D, Class B membrane shall be used when texture coating is specified.
	Chemical Admixtures	Acceptance from Qualified Products List				Admixture must be on approved list and have the brand shown on concrete design. Check dosage amounts for compliance with concrete design.
	Aggregate: Coarse and Fine	Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material.
	Completed Concrete Mix	Compressive Strength (Cylinders) Slump, Air Content, Mix Temperature *All early break cylinders shall conform to the requirements as stated in Part 1 of the SOP Guide.	Project Inspector	*One pair each 400 yd^3; In areas where class A is allowed, the frequency shall be the same as Portland Cement Concrete.	Placement site	Additional test specimens required if pavement is to be opened to traffic within 14 days after placement. Determine Slump and Air Content from same sample of mix used for cylinders. Make additional Slump and Air Content determinations as required for control. Use 6x12 cylinders for Class CP concrete. ***Complete set of tests shall be performed on the initial load for quality control/informational purposes, not for acceptance.**
		Depth Measurement	Contractor Monitored by Project Inspector	One core per 1,000 linear feet of poured width, with a minimum of 1 core for each interchange ramp	Completed pavement	When thickness of core from a unit is deficient more than 1/4" and not more than 1" from plan thickness, take 2 additional cores at intervals of not less than 300' within the unit. Use the average of the three cores to determine thickness.
	Dowel and Tie Bars	Acceptance by Certification (Verification sampling required)				Assembly to be approved by the Engineer.
	Sealant	Acceptance by Qualified Products List				
Prestressed Concrete	Cement, Fly Ash, and GGBFS	Acceptance from Qualified Products List (Verification sampling required)				Must be from approved source or have complete lab tests before being used on project.
	Curing Compound	Acceptance from Qualified Products List (Verification sampling required)				
	Chemical Admixtures	Acceptance by Qualified Products List				Admixture must have the brand shown on concrete design. Check dosage amounts for compliance with concrete design.
	Aggregate: Coarse and Fine	Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material.
	Reinforcing Steel (Bars)	Acceptance by Certified Mill Test Report (Verification Sampling Required)				
	Prestressing Strands	Acceptance by Certified Mill Test Report (Verification Sampling Required)				
	Finished Product	Visual Inspection	Materials & Tests	After casting and before shipment	Prestress producer's plant	Each item to be inspected for straightness, cracks, honeycomb, size and appearance. Cosmetic patching shall be cured prior to shipment.
	Completed Concrete Mix	Slump, Air and Mix Temperatures	Materials & Tests or Contractor monitored by TDOT personnel	1 set of tests per pair of cylinders	At discretion of inspector or min. of one per pour	Additional tests performed when apparent slump change is indicated or as directed.
		Cylinders (Beams)	Materials & Tests or Contractor monitored by TDOT personnel	At least 1 pair at the beginning, middle and end of the bed		1 pair for 28 day strength, 1 pair for back up
		Cylinders (Panels/Piling)	Materials & Tests or Contractor monitored by TDOT personnel	One pair at beginning, and one pair at the end of the pour		1 pair for 28 day strength, 1 pair for back up
		Cylinders (Tension Release)	Materials & Tests or Contractor monitored by TDOT personnel.	One pair at beginning, one pair at end for tension release of bed		Additional specimens may be necessary

PART TWO: ACCEPTANCE SAMPLES AND TESTS

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Precast concrete noise wall panels, retaining wall panels, and precast drainage structures including pipes, headwalls, manholes, catch basins, box culverts, and structural spans	Finished Product	Acceptance by Certification in accordance with SOP 5-3 (Verification sampling required)				Each shipment must be accompanied by a completed certification form. Each item shall be inspected after delivery to the project for cracks, spalls and/or appearance by project personnel prior to incorporating product into the work.
Precast Concrete Abutment Blocks and Approach Slabs	Finished Product	Slump, Temperature, and Air	Materials & Tests or Contractor monitored by TDOT personnel	Minimum 1 set of test per pour	Precast producer plant	
		Cylinders	Materials & Tests or Contractor monitored by TDOT personnel	One set at beginning, and 1 set at the end of the pour	Precast producer plant	
Earth Retaining Structures	Backfill	Density	Project inspector	1 per every 500 tons or fraction there of	Project site	
		Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material.
	Select Granular Backfill	Quality pH Internal angle of friction	Materials & Tests	1 @ beginning of Project and then every 6 months	Aggregate plant	
		Density	Project inspector	1 per every 500 tons	Project site	
		Eletro-Chemical Analysis	Producer	1 per Source @ Beg of Project & every 2 years thereafter	Aggregate plant	Additional Test required w/ appearance change
		Gradation	Materials & Tests	Beginning of project	Aggregate plant or Roadway	
			Project Inspector	One test every 1000 tons (Min. 1 per week)	Aggregate plant or Roadway	
	Finished Product	Precast concrete Products	Acceptance in accordance w/SOP 5-3 and Special Provision 624 Retaining Walls (Verification testing required)			
		Modular block	Acceptance in accordance w/Special Provision 624 Retaining Walls (Verification testing required)			Verification required before use
Prime, Tack and Sealer	Emulsions	Acceptance by Certification in accordance with SOP 3-2 (Verification Sampling Required)				Each shipment must be accompanied by TDOT form DT-0293E materials certification report.
Prime Tack and Sealers (Small Quantities)	Emulsions	Visually inspect for contamination	Project Inspector	1 per project	Project Site	Not to exceed 3 tons tack and 3 tons prime per project. Supplier to furnish certification (may be non-project specific) and delivery tickets showing quantities.
Bituminous Plant Mix Pavements	Aggregate	Acceptance from Producer's Supplier's List (Verification Sampling Required)				Must be approved material.
		Fractured Face Count, Glassy particles by weight	Project Inspector	Min. of 1 per project	Coarse aggregate Stockpile	Plus #4 (4.75mm) Material
	Performance-Graded Asphalt Cement	Acceptance by Certification in accordance with SOP 3-1 (Verification Required in accordance with Part Three herein)			Governed by process See SOP 3-1	Each shipment must be accompanied by TDOT form DT-0293PG materials certification report.
	All Plant Mix Asphalt	Mix temperature	On Roadway by Project Insp.	Every fifth load.	From truck prior to leaving plant and on roadway prior to deposit into paver or transfer device.	Temperatures to be recorded on the delivery ticket. Tests at the plant by producer at the discretion of Materials & Tests Supervisor.
		Stripping-10 min. boil test	Project Inspector	Once daily	Truck and Asphalt Plant	Plus #4 (4.75mm) Material on selected visually from mix sample.
	Plant Mix Asphalt Gradings A, B, BM, BM2, C, CW, D, E, and E Shoulder	Density	Project Inspector	1,000 tons	As soon as practical after compaction, when nuclear method is used. When used, cores will be obtained in accordance with SP407DEN.	Each lot shall be divided into 5 equal-sized sublots, and one test should be performed per each sublot. Longitudinal test locations should be determined randomly. Transverse locations are determined randomly with one test 1' off each edge, one test in each wheel path, and one test in the center of the lane.

PART TWO: ACCEPTANCE SAMPLES AND TESTS

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Embankment	Soil	Proctor Density & Optimum Moisture	Materials & Tests	As required by material changes	Cuts sampled prior to construction. Borrow pits sampled as required prior to placement.	
		Density, Moisture	Project Inspector	One test each 10" of lift not to exceed 1500 ft roadway or 5000 yd^3. Exception: Within 50 ft of a bridge end (deck or box) 1 test will be performed for each lift. The test will be performed alternately on the embankment and on the backfill material.	All tests will be performed at random locations. During construction, immediately after compaction.	Density tests will not be required for embankment containing more than 50% of plus 3/4" sieve material. See Standard Specs. 205 for correct formation of embankment.
Subgrade Preparation	Soil	Proctor Density & Optimum Moisture	Materials & Tests	As required by material changes.	May be sampled before grading construction or after grading prior to sub-grade preparation.	
		Density, Moisture	Project Inspector	5 tests per10,000 yd^2 lot for top 6 inches	Immediately before placing pavement structure	Average of 5 tests in lot used to determine pass-fail, with no individual test below 95% of Proctor. Average lot to be no less than 100%.
Subgrade Treatment: Lime	Soil-Lime Mixture	Proctor Density, Optimum Moisture	Project Inspector	Prior to beginning of construction	At beginning of compaction	Additional tests may be required to account for material changes. Prior to beginning of construction, samples of soil & lime will be submitted to Central Lab for Proctor Density lab tests.
		Density, Moisture	Project Inspector	5 tests per 10,000 yd^2 lot	Immediately following compaction	Average of 5 tests in lot to determine pass - fail.
		Pulverization	Project Inspector	1 test per 10,000 yd^2	At the beginning of compaction	Sieve test requirement See Standard Specs. 304.06
		Thickness	Project Inspector	5 tests per 10,000 yd^2	Job site	
Soil-Cement Base	Cement	Acceptance by Certification (Verification Sampling Required)				Cement must be from an approved source or be approved prior to use.
	Water	Visual Inspection	Project Inspector	At the beginning of work	As source changes	
	Soil-Cement Mixture	Pulverization	Project Inspector	1 test per 10,000 yd^2	After mixing, before compaction	See Standard Specs. 304.06
		Density, Moisture	Project Inspector	5 tests per 10,000 yd^2 lot	Immediately following compaction	Average of 5 tests in lot to determine pass - fail
		Thickness	Project Inspector	5 tests per 10,000 yd^2 lot	After final finish of base	

PART TWO: ACCEPTANCE SAMPLES AND TESTS

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Aggregate - Lime Fly Ash Base Course	Hydrated Lime	Acceptance by Certification (Verification Sampling Required)				Must be from approved source or tested and approved prior to use.
	Fly Ash	Acceptance from Qualified Products List (Verification Sampling Required)				Must be from approved source or tested and approved prior to use.
	Aggregate	Gradation	Project Inspector	One each 2500 tons	Sampled from plant stockpile.	Must be from approved source. In special cases, this test is performed by Materials & Tests.
	Water	Quality	Project Inspector	At the beginning of construction and when source changes	Source prior to start of work	Water of potable quality may be used without testing.
	Aggregate-Lime-Fly Ash Mixture	Density, Moisture	Project Inspector	5 tests per lot of approximately 10,000 yd^2	Immediately following compaction	Average of 5 tests in lot used to determine pass - fail. Not required for Cement Treated Permeable Base.
		Thickness	Project Inspector or Survey Party	Five test holes per lot of approximately 10,000 yd^2 or profile check at each break point at 50 ft intervals	After base completed	On test holes - lot average considered one test
		Moisture	Project Inspector	1 each 2500 tons or 2 per day	At time of weighing	First sample should be taken at beginning of day
Conditioning Mineral Aggregate Base	Aggregate	Optimum Moisture	Materials & Tests	1 per project and as materials change	Sampled from roadway prior to beginning the conditioning	
		Proctor	Materials & Tests	1 per year for producers or as material changes	Sampled from roadway prior to beginning the conditioning	
		Density, Moisture	Project Inspector	5 tests per 10,000yd^2 lot	Immediately following compaction	Average of 5 tests per lot used to determine pass - fail
	Calcium Chloride, Sodium Chloride	Chemical Analysis	Project Inspector	1 sample each shipment to project	Sampled from stock before use	Submit sample to Headquarters Lab for testing
Miscellaneous and Small Quantities For Non-Critical Items	Aggregate: For use other than in Portland Cement Concrete	Visually inspect for contamination	Project Inspector	Occasionally	Placement site	Must be from approved source. Not to exceed 100 tons per day nor more than 500 tons per project. For use in pipe bedding, underdrains, etc.
	Masonry Items including: Concrete Block, Brick, R/W Markers	Visual Inspection and Dimension Check	Project Inspector	Occasionally	Placement site	Supplier to furnish certification. Not to exceed: Concrete block - 100 Brick ---------- 1,000 R/W markers --- 20
	Fence Fabric or Wire, Fence Posts & Braces, etc.	Visual Inspection and Dimension Check	Project Inspector	Occasionally	Placement site	Not to exceed 1000 lin. Ft. (300 m) per project. Supplier to furnish certification.
	P.V.C. Pipe and Underdrain Pipe 300 mm (12") D	Visual Inspection and Dimension Check	Project Inspector	Occasionally	Placement site	Not to exceed 500 lin. ft. per project. Supplier to furnish certification.
	Delineators & Posts	Acceptance from Qualified Products List (No Verification Sampling Required)				Not to exceed 100 pieces of each per project. Supplier to furnish certification.

April 1, 2004
October 17, 2012
REV: February 20, 2014

Tennessee Department of Transportation
Division of Materials and Tests

Quality Control and Acceptance of Portland Cement Concrete for Bridge Decks (SOP 4-1)

Purpose- The purpose of this document is to establish the minimum TDOT requirements for the quality control and acceptance testing of Portland cement concrete for bridge decks.

Background- Quality control for concrete, both at the plant and at the job site, is critical to the final performance. Though designs call for 7% air content, many loads of concrete are being rejected due to air content below the minimum of 4.5%. Other loads of concrete are rejected due to being out of specification on slump or temperature. This costs both the contractor and the TDOT in both time and money. It has been determined that a better system, one in which the quality control testing at the plant cooperates with that at the job site, be developed in order to cut these losses and promote better quality concrete.

Procedure- Before any deck pour there shall be a "pre-pour conference". The purpose of the conference shall be to discuss the Quality Control (QC) and acceptance procedures and responsibilities. A representative from the contractor and/or subcontractor, ready-mix supplier, concrete pump operator (if applicable), and the Tennessee Department of Transportation shall attend. The authority and responsibilities for each of the following shall be discussed: addition of water, plant operations, concrete mix design, boom configurations, sampling and testing, concrete delivery/# of trucks, specifications, acceptance testing, and mixture rejection. A TDOT or ACI Level One Certified Technician shall complete all QC and Acceptance sampling and testing. As required in Section 604.03 of the TDOT Specifications, the Contractor or concrete material supplier shall complete all QC sampling and testing. The TDOT inspector shall conduct all acceptance sampling and testing for air content, slump, and temperature. The TDOT inspector shall also make, cure, and transport the acceptance cylinders for strength testing.

During placement operations, whether by direct pouring, by bucket, or by pumping, there is an assumed air loss. Research has shown that an air loss of 0-2.0% as a result of pumping can be expected. Furthermore, it is assumed that a smaller air loss can be expected during other placement means, and during finishing. This air loss will be assumed to be 0.5%. These assumed air losses shall be addressed as follows:

Bridge Deck Concrete placed by pumping or other placement methods shall have an air content of **4.5% - 7.5%** at the discharge end of the truck chute* immediately prior to pumping or placement, no exceptions. The concrete shall be tested before placed in the pump truck, bucket, or deck. Any load of concrete failing to meet these specifications or those for slump or temperature, shall be rejected and not used in a TDOT project.

Each truck shall be tested for air content, slump, and temperature at the beginning of each day until three consecutive trucks meet specification. Once that specific truck meets specifications, it shall be allowed to pour. One set of cylinders shall randomly be cast from one of the first three passing loads. Thereafter QC and acceptance testing shall be conducted at least once every fifty cubic yards (50 CY), including cylinders for compressive strength. The samples taken every fifty cubic yards (50 CY) are to be taken randomly within the lot, so as not to establish a pattern, i.e. every fifth truck. Should a load be found not to be in the allowable air content, slump, or temperature range, then it shall be rejected. Each truck thereafter is to be tested until two consecutive trucks are found to be within the acceptable range(s). At that point, testing frequency shall return to at least once in every fifty cubic yard (50 CY) lot.

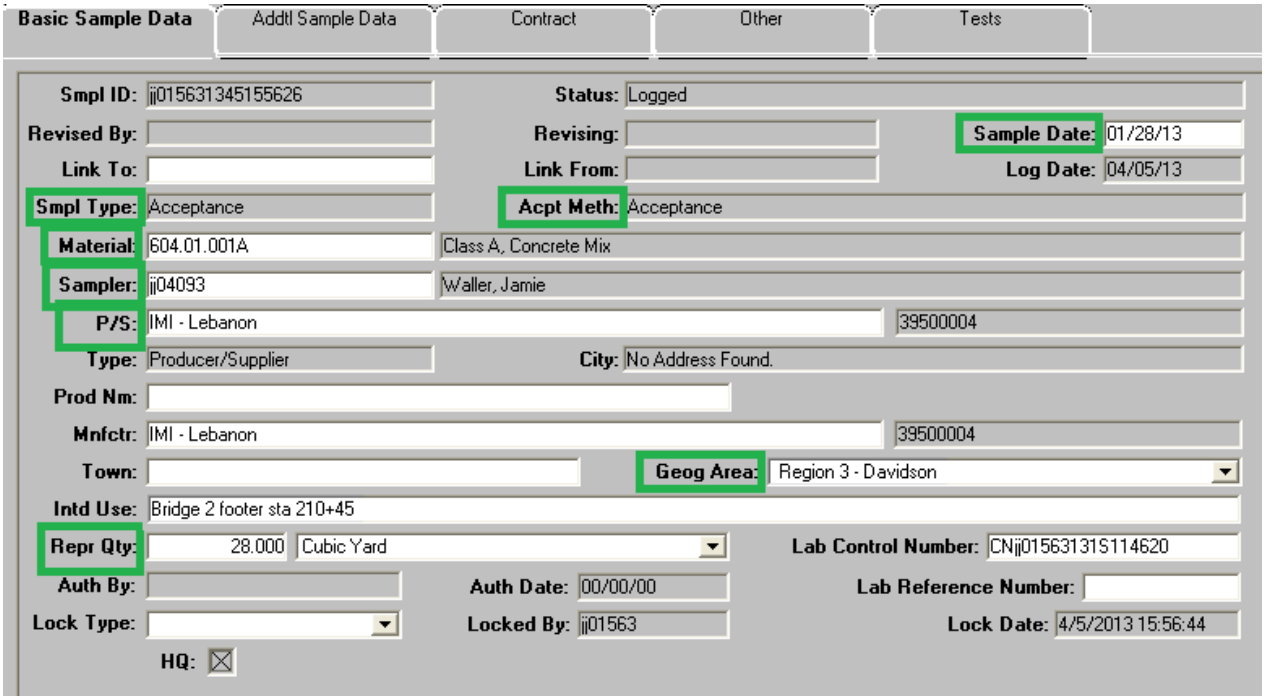
All QC and acceptance test results conducted in accordance with this procedure shall be documented on TDOT form DT-0311 and DT-0311A.

- The TDOT/Consultant Inspector may request additional Q.C. testing at any time at either the plant or at the job site, including during the pumping operation. The TDOT/Consultant inspector and the Contractor QC technician have full authority to reject any truckload of concrete not in compliance with this procedure or with the TDOT Specifications.
- If taking a concrete sample during pumping operations, the pump is not to be stopped. The sample is to be obtained from the pumped concrete stream during placement.
- Before concrete is placed, it must be in full compliance with the TDOT specifications including air content, slump, temperature, and time. Any mixture not in compliance shall be rejected.
- When possible, a TDOT Project Inspector should either be at the ready mix plant, or make a short visit to the plant to assure proper Q.C. techniques and procedures.

*Sample per AASHTO R 60, Section 5.2, Note 3: sample for tests may be taken after at least one-quarter cubic yard of concrete has been discharged.

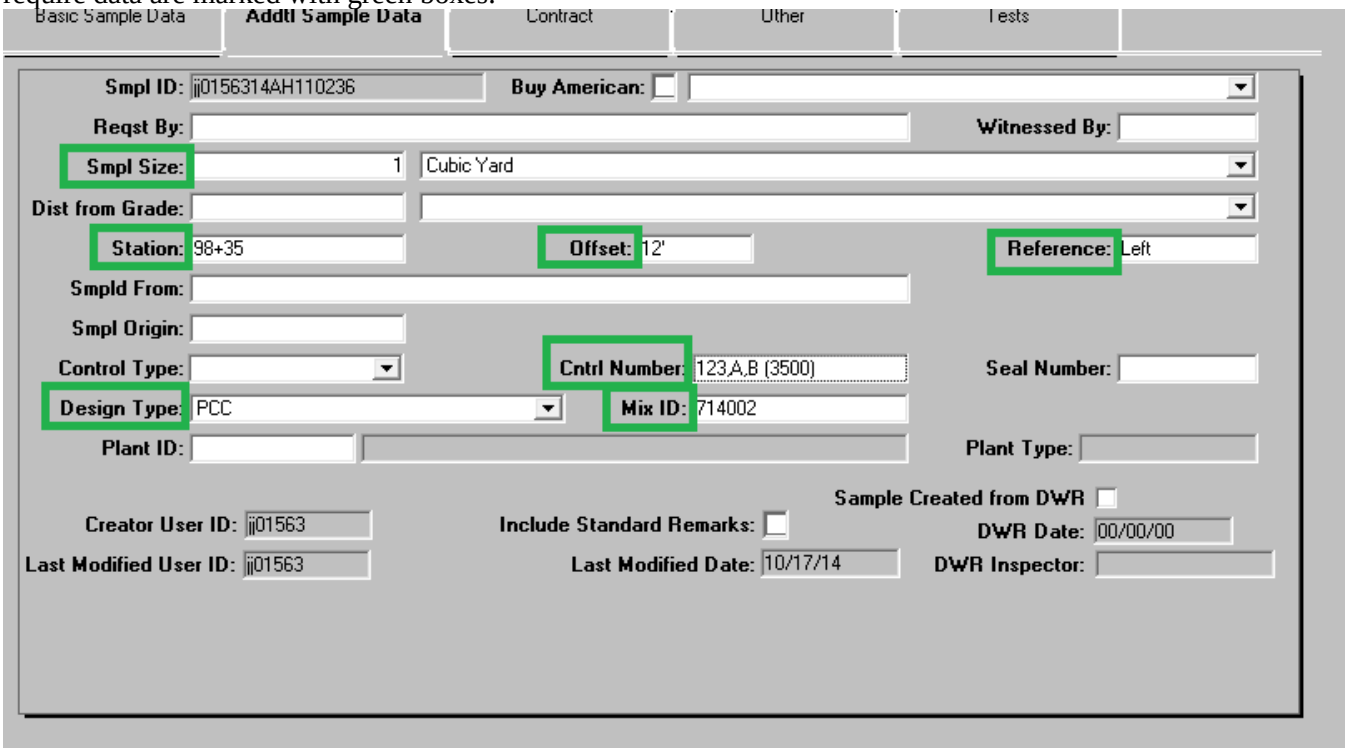
FIELD - Operations Inspector Performs Concrete Field Tests

Open the Maintain Sample Information window (main panel/Materials Management/Sampling and Testing/Sample Information) to create a new sample record. The system displays the **Basic Sample Data** panel.



In the **Intd Use** field note the location where represented material was used on the job (in case cylinders fail and/or cores need to be taken). If the field is not big enough for locations details, use the remarks field (Icon at top of window) to give location details. In the **Repr Qty** field, type the overall quantity the sample represents.

Click the **Addtl Sample Data** tab. The system displays the **Addtl Sample Data** panel. Fields that require data are marked with green boxes.

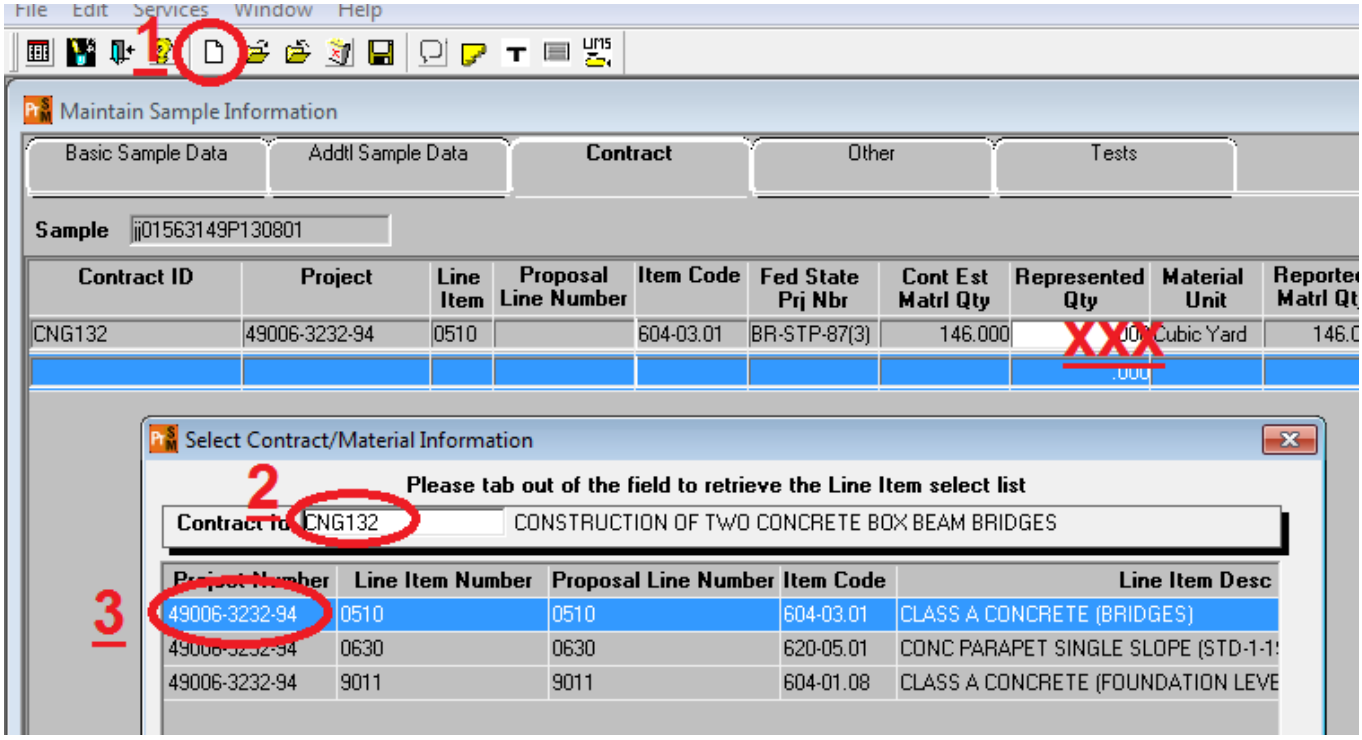


Mix ID field, **Warning!** The mixes available are all approved and associated to the selected material code, but are not filtered by any contract. Confirm the mix ID against paperwork and the Contract Mixes window.

If cylinders are to be made, enter the cylinder numbers in the **Control Number** field. Example: 234,A,B

> **Note:** Although it is a rare occurrence, if the concrete mix design has a 'Required Average Minimum Strength' greater than the standard 3000 or 4000 psi, note the required strength in parenthesis after the cylinder numbers for the Lab Tech and Lab Supervisor performing and approving tests. Example: **234,A, B (3500)**

Click the **Contract** tab. The system displays the **Contract** panel.



Now, record the contract items that the sample represents.

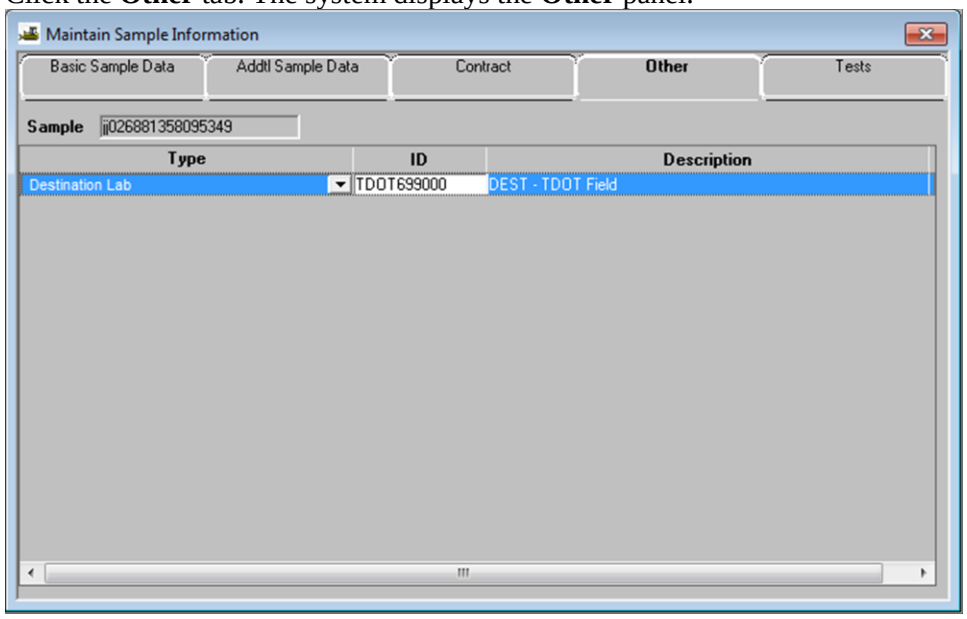
1 On the toolbar, click **New**. Then,

2 search for and select the desired contract

3 select the desired contract line item(s)

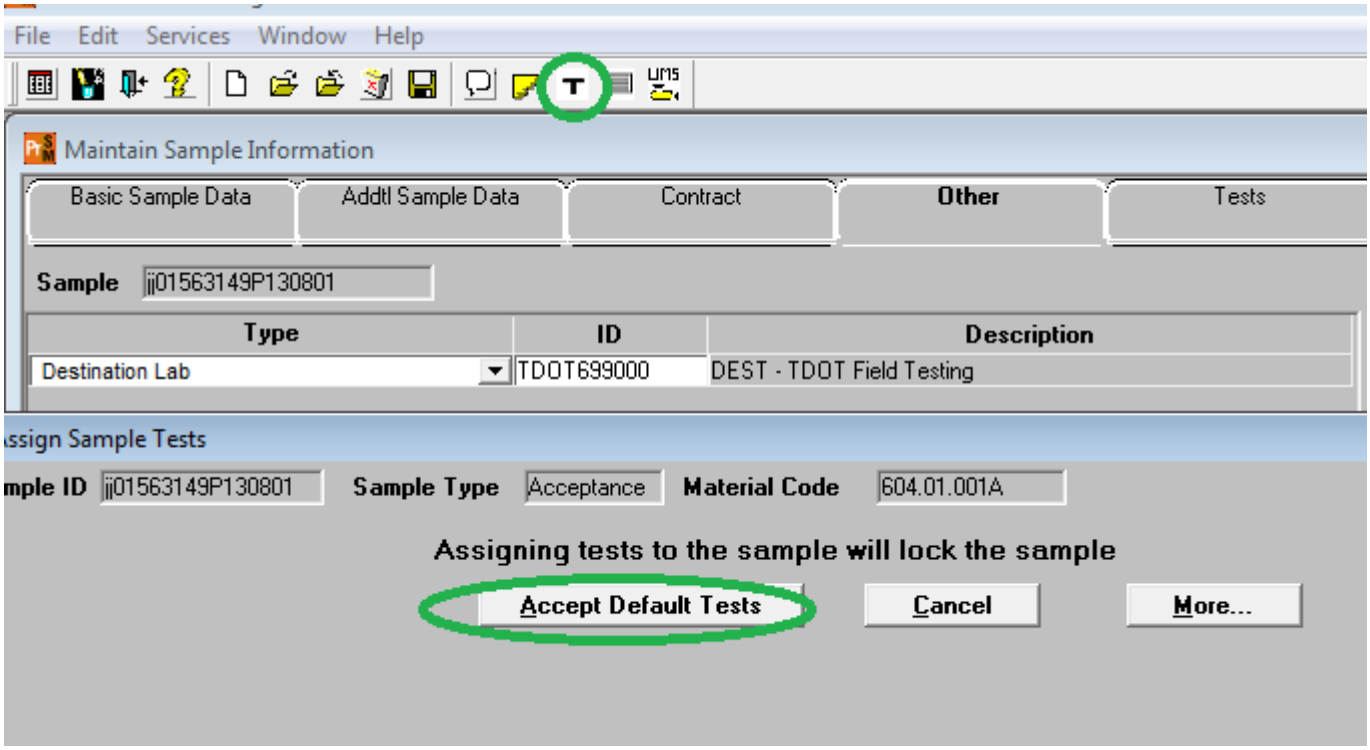
Warning! Do not enter a quantity. The quantity to be paid is entered in a DWR. The material has a rate/frequency of testing linked to it, and entering a quantity here will possibly cause a shortage of test results resulting in money being withheld.

Click the **Other** tab. The system displays the **Other** panel.



In the **Type** dropdown list, select **Destination Lab**. In the **ID** field, search for and select **DEST - TDOT Field Testing**. **Save**.

Now, assign tests.



On the toolbar, click the **Open Assign Tests** button. The system displays the Assign Sample Tests window.

Click the **Accept Default Tests** button. The system associates 'M016 - Field Tests of Freshly Mixed Concrete' to the sample record.

You are now ready to either navigate to LIMS and enter test results or copy sample to prepare sample for cylinders.

Rev 12/28/15

FIELD - Operations Inspector Casts Cylinders and Creates Sample Record

1. Cast the cylinders in the field.

2. Once the surface of sampled material dries enough, write the sample taken date, contract ID and cylinder number on the top with a permanent marker.

Now, open and copy the air/slump/temperature sample record.

3. Open the Maintain Sample Information window (main panel/Materials Management/Sampling and Testing/Sample Information)

4. In the Maintain Sample Information window, on the toolbar, click the **Open** button. Scroll to and double-click the air/slump/temperature sample record.

   Tip! If the air/slump/temperature sample record was still open in Maintain Sample Information window, from the **File** menu, select **Refresh** (CTRL + F) to update the sample status.

5. From the **Services** menu, click the **Copy Sample** choice. SiteManager displays the Copy Sample window.

6. Select **Copy lab control number from existing sample**.

7. Click the **OK** button. SiteManager displays the copied sample record in the Maintain Sample Information window. Verify all needed data copied over to new sample, add if any is missing. **Make sure "Sample Taken Date" field has correct date that physical cylinder sample was created. HQ lab will use this date to calculate due date for testing cylinders.**

8. **Save**.

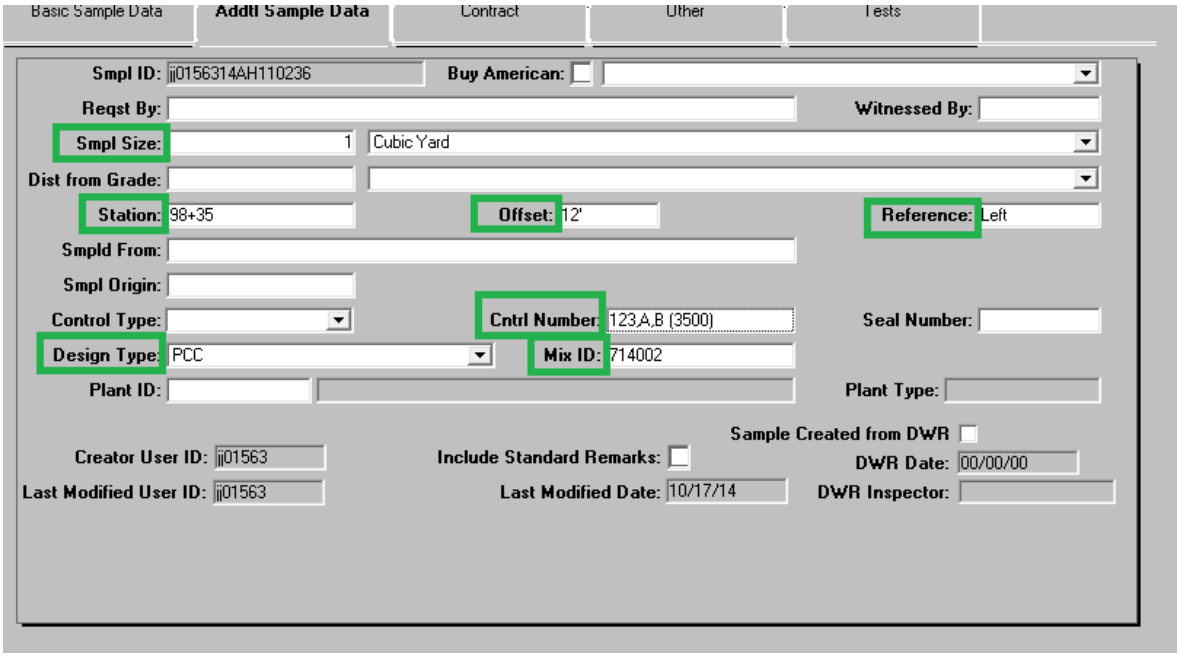


Figure 1. Maintain Sample Information Window – Addtl Sample Data Panel

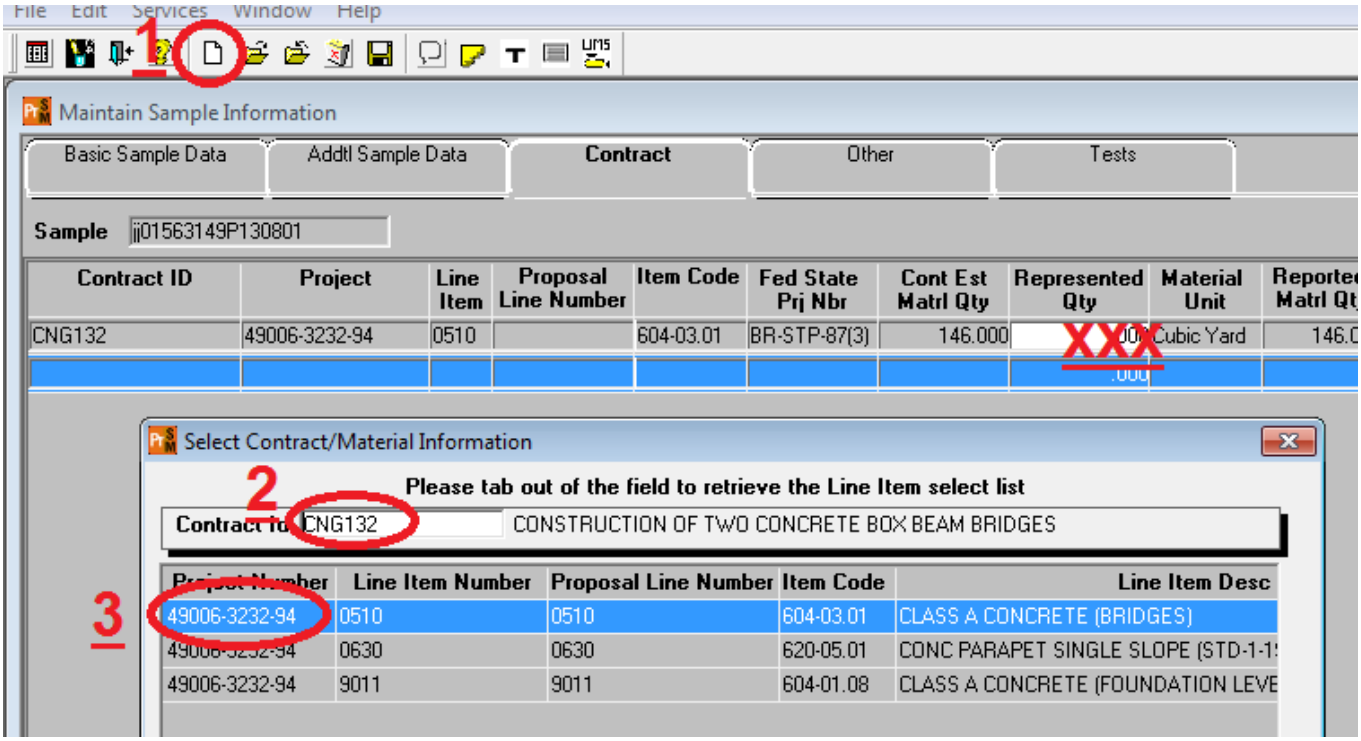
9. Click the **Addtl Sample Data** tab. The system displays the **Addtl Sample Data** panel. Design type, Mix ID & info in Cntrl Number field should transfer from copied sample. Verify this data is there.

Below are some details about the the cylinder numbers represented by this sample record.

In the **Control Number**, enter the cylinder numbers. Example: 234,A,B

Note: Although it is a rare occurrence, if the concrete mix design has a 'Required Average Minimum Strength' greater than the standard 3000 or 4000 psi, note the required strength in parenthesis after the cylinder numbers for the Lab Tech and Lab Supervisor performing and approving tests. Example: **234,A, B (3500)**

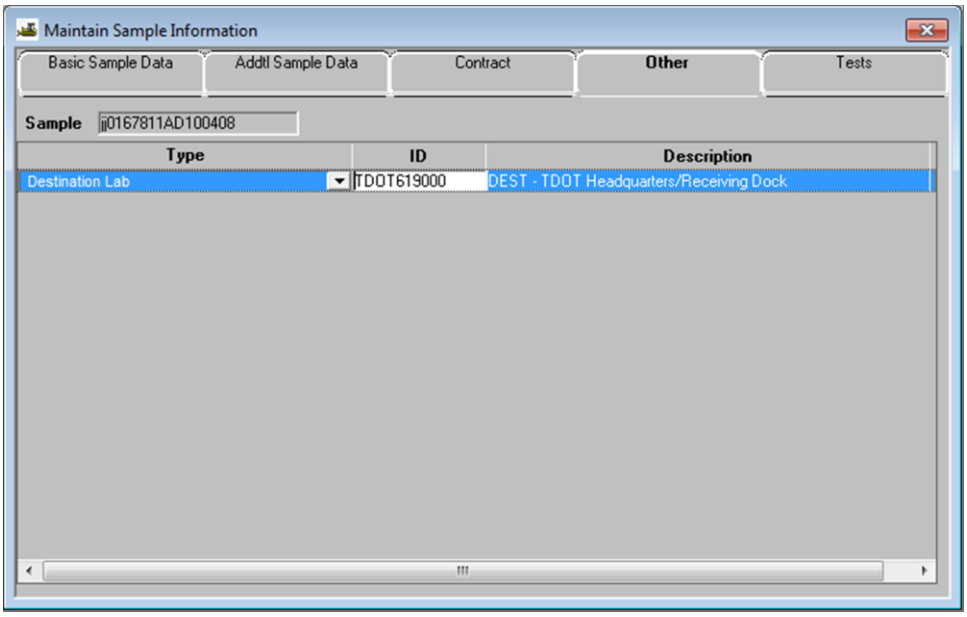
10. **Save**.



11. Click the Contract tab. The system displays the Contract panel.

12. Verify this copied sample kept the contract items that the sample represents.

13. Warning! Do not enter a quantity. The quantity to be paid is entered in a DWR. The material has a rate/frequency of testing linked to it, and entering a quantity here will possibly cause a shortage of test results resulting in money being withheld.



14. Click the **Other** tab. The system displays the **Other** panel.

Now, record the location where the testing will be performed.

15. In the **Type** dropdown list, select **Destination Lab** if it is not already populated.

16. In the **ID** field, search for and select **DEST – TDOT Headquarters/Receiving Dock**.

    Note: While acceptance cylinders always go to the TDOT Concrete Cylinder/Core Lab, intermittent cylinders (that is, 7- or 14-day),will not be tracked in SiteManager and will be sent to the appropriate TDOT regional lab with completed form DT-0062.

17. **Save**.

Now, assign tests.

1. On the toolbar, click the **Open Assign Tests** button. The system displays the Assign Sample Tests window.

18. Click the **Accept Default Tests** button. The system associates 'T22 - Compressive Strength of Cylindrical Concrete Specimens' [Template: T22] to the sample record.

19. **Save Tests**. The system displays the Maintain Sample Information window's **Other** panel.

20. Set the cylinder aside to cure.

    NOTE: The inspector who created the cylinders will be responsible for making sure correct "Date Transported to Wet Curing" is added to the "Other" tab of the sample record when the cylinders are transported.

FIELD - Operations Inspector Prepares and Delivers the Cylinders to the Regional M&T Lab

1. Strip the molds from the cylinders.

21. Deliver the cylinders to the regional M&T lab.

HQ Lab performs testing

1. If cylinders break above required strength, no notifications we be sent to Operations or Regional M&T Staff. There are several methods anyone who wants/needs to see the results can access the data

    i. Run BOE report RR038-Cylinder Breaks - List

    ii. Open sample record in SiteManager, go to "Tests" tab. Select test T22. Then go to "Services" menu and select "Enter/View Test Results". Read only version of the test template w/ results will open in new window.

    iii. Break info will also be posted on-line for persons without SiteManager access.

2. If the cylinders break below required strength, automatic notifications will be sent to the Operations unit & Materials & Tests office in charge of the contract. Below are the steps to be followed in that circumstance

Regional M&T Runs Report for Deficient Strength

Scenario: For the cylinder breaks that do not meet the requirements for strength, the following occurs:

3. Regional M&T personnel run the *Concrete Evaluation for Deficient Strength* [Report: RR050] report and print it. This report includes: the sample IDs of the cylinders that failed; item codes, and locations where the defective concrete was used; and the average strength of the cylinders breaks.

4. Send the printed report to the FIELD - Operations Office Staff.

5. Regional M&T personnel calls FIELD - Operations Office Staff to notify them of the low break.

FIELD - Operations Office Staff Notifies the Contractor of Deficient Strength

1. If the contractor decides not to core, FIELD - Operations Office Staff uses this report to create the deduction in SiteManager.

   If the contractor decides to core, REG - M&T Inspector copies and edits the acceptance cylinder sample record with the **Failed, but Left in Place** sample status. Including copying the Lab Control Number. Follow the same process used to send a cylinder through the queues, with the addition of writing the sample ID **legibly (neatly)** on the side of the core.

2. If the cores still do not meet strength requirements, Regional M&T personnel run the *Concrete Evaluation for Deficient Strength* [Report: RR050] report and print it. Send the printed report to the FIELD - Operations Office Staff. FIELD - Operations Office Staff will use this report to aid in creating the deduction in SiteManager.

TN TDOT Department of Transportation

MEMO

To: Regional Materials & Tests, Regional Operations
From: HQ Materials & Tests, HQ Construction
Date: November 16, 2016
Subject: Concrete Cylinder Acceptance

Effective immediately, concrete strength acceptance testing will be performed utilizing (2) 4"x8" concrete cylinders for all classes of concrete except Class CP on all contracts. Class CP concrete will continue using (2) 6"x12" cylinders. These requirements are outlined in SOP 1-1: Procedures for the Sampling and Testing, and Acceptance of Materials and Products. Prior to this update, we were requiring the submittal of (3) cylinders when the 4"x8" were utilized.

It is imperative that proper procedures are followed during the making, curing, handling, and transporting of cylinders. It is the responsibility of the Contractor to provide proper storage and handling of the concrete cylinders. It is the responsibility of the Project Supervisor to emphasize to the contractor at the pre-construction meeting, pre-pour meeting and the day of the pour the importance of having proper curing equipment (i.e. curing box) on the project site for the concrete cylinders. The Project Supervisor is responsible for ensuring that proper storage is on-site prior to any concrete being placed on the project site. The Department will have the only keys to the storage facility and will control access at all times. Early break cylinders may be stored in the secured curing box if granted access by the Department personnel assigned to the security of the storage area. At no time shall the Contractor have keys to the storage facility.

Immediately after making the concrete cylinders they shall be kept in a controlled temperature environment between 60˚-80˚F for up to 48 hours. If a curing box is used for initial curing, the temperature shall be maintained especially during hot weather concreting. Initial curing of acceptance cylinders should be discussed during the pre-pour conference. Acceptance cylinders shall be picked up from the project site and delivered to a location for final (wet) curing where the cylinders will be stored in an environment with free water maintained on the surface at all times at a temperature of 73.5˚ ± 3.5˚ F until time of test. Cylinders shall be transported to Headquarters Materials and Tests Laboratory for acceptance testing as soon as possible but within 21 days. Form DT 0062 Concrete Cylinder Test Report shall be filled out in its entirety including the "Date Placed in the Wet Curing Environment".

Please review and advise personnel of these procedures.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
MATERIALS & TESTS DIVISION
6601 CENTENNIAL BOULEVARD
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JOHN C. SCHROER
COMMISSIONER

BILL HASLAM
GOVERNOR

To: Regional Operations Staff
Regional Materials & Tests

From: Lori Lange, PE, Construction Division Director
Brian Egan, PE, Materials and Tests Division Director

Date: November 14, 2017

Subject: Concrete Cylinder Acceptance

In light of the vast amount of staff changes and the implementation of newer field personnel to our construction projects, this memo is being sent as a reminder of the proper procedures for concrete cylinder acceptance. There have been several observations recently of unacceptable curing practices and it is essential to bring attention to the proper procedures for the curing and handling of the concrete cylinders.

It is imperative that proper procedures are followed during the making, curing, handling, and transporting of cylinders. If any of these processes are done incorrectly, the strength of the cylinders will be affected and unnecessary price adjustments may be assessed. It is the responsibility of certified TDOT staff to sample and test concrete as stated in SOP 1-1 (temperature, slump/flow, air content, strength) and to properly make and cure acceptance cylinders as stated in the applicable AASHTO Standards. It is the responsibility of the Contractor to provide proper storage on site for the curing of the concrete cylinders (§501.03, 604.03, and 722.09 of the TDOT Standard Specifications).

It is the responsibility of the District Operations Staff to emphasize to the contractor at the pre-construction meeting, pre-pour meeting and the day of the pour the importance of having proper curing equipment (i.e. curing box) on the project site for the concrete cylinders. The Project Supervisor is responsible for ensuring that proper curing and storage facilities are on-site prior to any concrete being placed on the project site. In order to maintain the proper "Chain of Custody", TDOT is to have the only keys to the storage facility and will control access at all times. Contractor provided early break cylinders are allowed to be stored in the secured curing box if Department personnel provide access. At no time shall the Contractor have keys to the storage facility.

Immediately after making the concrete cylinders, they shall be kept in a controlled temperature environment between 60°-80°F for up to 48 hours and not in direct sunlight. If a curing box is used for initial curing, the temperature shall be maintained especially during hot weather concreting. Initial curing

of acceptance cylinders should be discussed during the pre-pour conference. Acceptance cylinders shall be picked up from the project site and delivered to a location for final (wet) curing where the cylinders will be stored in an environment with free water maintained on the surface at all times at a temperature of 73.5° ± 3.5° F until time of testing. Cylinders shall be transported to Headquarters Materials and Tests Laboratory for acceptance testing as soon as possible but within 21 days. Form DT 0062, "Concrete Cylinder Test Report", shall be filled out in its entirety including the "Date Placed in the Wet Curing Environment".

Please refer your staff to the "Construction Division Job Box ", Construction Guide, Chapter 6, Structures, page 6-38 for the short video on the making and curing of concrete cylinders and emphasize the importance of making and curing cylinders properly (AASHTO T-23).

The photo above, from a TDOT project, shows that the cylinders are not made on a level platform; some cylinders are capped to prevent moisture loss while others are not; the cylinders are not protected from direct sunlight, and the proper curing equipment and storage area are not present

REFERENCES:

Section 501.03B- "Provide cylinder molds, a wheelbarrow, and a level site to perform testing and for initial curing. Provide a secure storage shed/building for temporary storage of concrete acceptance cylinders as specified in **722.09.**"

Section 604.03- "Meet the requirements of 501.03.B."

Section 722.09- "Provide a storage shed/building for temporary storage of concrete acceptance cylinders. The storage facility shall be of sufficient size and construction to protect the concrete cylinders from the elements and damage. Obtain the Engineer's approval of the storage facility location. Department personnel will control access to the storage shed/building. Equip the storage shed with a concrete curing box or water curing tank with a heating/circulating system of sufficient size to properly cure all acceptance cylinders before transferring for final storage and testing. The curing box or curing tank and heater/circulator shall comply with AASHTO M 201, and proper curing of the cylinders shall be in accordance with AASHTO T 23."

AASHTO T-23- Section 10.1.2

Initial Curing—Immediately after molding and finishing, the specimens shall be stored for a period up to 48 h in a temperature range from 16 to 27°C (60 to 80°F) in an environment preventing moisture loss from the specimens. For concrete mixtures with a specified strength of 40 MPa (6000 psi) or greater, the initial curing temperature shall be between 20 and 26°C (68 and 78°F). Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (Note 8). Shield all specimens from direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by the use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. If cardboard molds are used, protect the outside surface of the molds from contact with wet burlap or other sources of water.

Note 8—A satisfactory moisture environment can be created during the initial curing of the specimens by one or more of the following procedures: (1) immediately immerse molded specimens with plastic lids in water saturated with calcium hydroxide; (2) store in properly constructed wood boxes or structures; (3) place in damp sand pits; (4) cover with removable plastic lids; (5) place inside plastic bags; or (6) cover with plastic sheets or nonabsorbent plates if provisions are made to avoid drying and damp burlap is used inside the enclosure, but the burlap is prevented from contacting the concrete surfaces. A satisfactory temperature environment can be controlled during the initial curing of the specimens by one or more of the following procedures: (1) use of ventilation, (2) use of ice, (3) use of thermostatically controlled heating or cooling devices, or (4) use of heating methods such as stoves or lightbulbs. Other suitable methods may be used if the requirements limiting specimen storage temperature and moisture loss are met. For concrete mixtures with a specified strength of 40 MPa (6000 psi) or greater, heat generated during the early ages may raise the temperature above the required storage temperature. When specimens are to be immersed in water saturated with calcium hydroxide, specimens in cardboard molds or other molds that expand when immersed in water should not be used. Early-age strength test results may be lower when stored at 16°C (60°F) and higher when stored at 27°C (80°F). On the other hand, at later ages, test results may be lower for higher initial storage temperatures.

CIRCULAR LETTER

SECTION: **604.03 CLASSIFICATION, PROPORTIONING AND QUALITY ASSURANCE OF CONCRETE**
NUMBER: **604.03-01**
SUBJECT: **CONCRETE DELIVERY TICKETS**
DATE: **APRIL 1, 2009**

When concrete is delivered to a project, it is the TDOT Inspector's responsibility to verify that the concrete delivery ticket includes the information specified in Section 604 of the Standard Specifications and/or Section 600 of the Supplemental Specifications.

The inspector should also verify the Batch Time and note the Discharge Time on the ticket. He/she should sign the ticket and keep a copy for the project records.

CIRCULAR LETTER

SECTION: **501.09 HANDLING, MEASURING AND BATCHING MATERIAL**
NUMBER: **501.09-01**
SUBJECT: **CONCRETE BATCH TICKETS**
DATE: **JULY 1, 1992**

The following is a suggested method for arriving at water calculations and proper recording of mixing revolutions:

Max. Water (Design) – This quantity represents the total amount of water that may be added at any time to the mix and still not exceed the water-cement ratio. For instance, if your concrete design indicates a mix based on 33 gal. per C.Y. with an additional 2.5 gal. per C.Y. noted under remarks, the Max. Water (Design) would be (33+2.5) 35.5 gal. per C.Y. times the number of C.Y. batched.

Total Water (Plant) – This quantity represents the amount of water metered into the mix plus whatever quantity was present in the aggregates indicated by your moisture tests. For instance, if the free moisture in the fine and coarse aggregate is 16 gals. and the amount of water metered is 246 gals., the Total Water (Plant) would equal 262 gals.

The difference in the above two quantities indicates to the roadway inspector the amount of water that may be added at the job site. The actual quantity added must be shown under Water Added (Project) even if the quantity is zero.

Mixing revolutions at the plant and job site are to be recorded. The mixing revolutions are to be witnessed by the inspector and noted on the tickets for all concrete. Trucks with revolution counters inoperable are not to be used.