Concrete Field Testing Technician

Recertification Course

Tennessee Department of Transportation

2020 Manual
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Table of Contents

1. Sampling Freshly Mixed Concrete................................................................. 5
2. Temperature of Freshly-Mixed Portland Cement Concrete ...................... 8
3. Slump of Hydraulic Cement Concrete .......................................................... 11
4. Unit Weight (Density) and Yield of Concrete ............................................. 14
5. Air Content of Freshly Mixed Concrete by the Pressure Method .............. 20
6. Air Content of Freshly Mixed Concrete by the Volumetric Method .......... 24
7. Making and Curing Concrete Test Specimens in the Field....................... 28
8. Self-Consolidating Concrete (SCC)................................................................. 33
9. Volumetric Concrete .................................................................................. 58
10. Appendix .................................................................................................... 62
Classroom Rules

• Be Respectful
• Facility Information
• Keep It Clean
• Phone Etiquette
Who Are YOU?

- Name
- Company
- Experience
- Why are you here?

Purpose of Certification

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

- Course schedule
  - Review test methods
  - Self-Consolidating Concrete
  - TDOT Specifications / Forms
- Examination
  - Written exam (No Phones Allowed)
  - Open-book
  - Must get 75% overall
  - Performance exam at a later date (Pass/Fail)
- Results
- Recertification - Every 5 years

Resources

- Course materials
  - Course textbook
  - Presentation slides and videos
- TDOT
  - Standard Specifications, January 1, 2015
  - Special Provisions
ADA Notice of Requirements

- Can be found at the following website:
- 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
Sampling Freshly Mixed Concrete

AASHTO R 60

ASTM C172
TDOT Standard Method of Test for

Sampling Freshly Mixed Concrete

References
TDOT Standard Specifications
AASHTO R 60
ASTM C172

Sampling

• Obtaining a representative sample from a revolving drum truck
  • Sample the concrete at two or more 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
  • Pass the receptacle through the entire discharge stream or completely divert the discharge into the sample container
• When sampling from a paving mixer, obtain at least 5 different portions then combine into one sample
Sampling

- Transport the sample to testing location
- Remix to form the composite sample
- Obtain the composite sample within 15 minutes
- Protect the sample against rapid evaporation and contamination
- Ensure that an accurate representation of the concrete in the truck is obtained

Sampling

- Start the tests for slump, temperature, and air content within 5 minutes after obtaining the final portion of the composite sample
- Start molding cylinders within 15 minutes after fabricating the composite sample
  - Minimum of 1 ft$^3$ required for making cylinders
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?
Temperature of Freshly Mixed Hydraulic Cement Concrete

AASHTO T 309
ASTM C1064
TDOT Standard Method of Test for
Temperature of Freshly Mixed
Hydraulic-Cement Concrete

References
TDOT Standard Specifications
AASHTO T 309
ASTM C1064

Temperature

• At least 3" of cover in all directions around the tip of the thermometer
  OR
• Cover at least 3 times the nominal maximum size of the coarse aggregate
**Temperature**

- Use an approved thermometer accurate to ±1°F
- Calibrate thermometers once a year or whenever there is a question of accuracy
- Concrete temperature at point of discharge shall not be greater than 90°F

---

**Temperature**

- Gently press concrete around the thermometer.
- 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 1°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?
3

Slump of Hydraulic Cement Concrete

AASHTO T 119

ASTM C143
TDOT Standard Method of Test for
Slump of Hydraulic Cement Concrete

References
TDOT Standard Specifications
AASHTO T 119
ASTM C143

Slump

- Applicable when coarse aggregate passes 1½” sieve
- Dampen the cone and the floor base plate
- Hold the cone firmly against the base by standing on the two foot pieces or locking onto the baseplate
- Fill the cone in three layers equal by volume
**Slump**

- Rod each layer 25 times, distributing the strokes uniformly over the cross section of each layer
- Rod the second and third layers to penetrate into the underlying layer approximately 1”
- Strike off concrete level with top of cone using the tamping rod

---

**Slump**

- Lift the cone upward 12” in one smooth motion, without twisting the cone, in 5±2 seconds
- Immediately measure the vertical distance from the top of the cone to the displaced original center, also known as slump, to the nearest ¼”
  - If the concrete shears or collapses, disregard and repeat the test on another portion of the sample
- Perform the test from start to finish within 2 ½ minutes
Table 604.03-2
Use of Chemical Admixtures

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Temperature less than 85°F and falling</th>
<th>Temperature 85°F or greater and rising</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type A or F</td>
<td>Type D or G or A and B</td>
</tr>
<tr>
<td>D, DS</td>
<td>Type A or F</td>
<td>Type A or F and B or G</td>
</tr>
<tr>
<td>L</td>
<td>Type F</td>
<td>Type F and B or G</td>
</tr>
<tr>
<td>S</td>
<td>Type D or G or A and B</td>
<td>Type D or G or A and B</td>
</tr>
</tbody>
</table>

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

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 ______.
Unit Weight (Density) and Yield of Concrete

AASHTO T 121

ASTM C138
TDOT Standard Method of Test for
Unit Weight (Density) and Yield of
Concrete

References
TDOT Standard Specifications
AASHTO T 121
ASTM C138

<table>
<thead>
<tr>
<th>Nominal Maximum Size of Coarse Aggregate (in.)</th>
<th>Minimum Capacity of Measure (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>1 ½</td>
<td>0.4</td>
</tr>
<tr>
<td>2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

ASTM C138: Table 1
Unit Weight

- Determine the weight of the empty container
- Fill the container in three equal layers
- Rod each layer with the tamping rod 25 times
- Rod the bottom layer throughout its depth, without forcibly striking the container
- Rod the middle and top layers so that the strokes penetrate the previous layer by approximately 1”

Unit Weight

- Distribute the strokes uniformly for each layer
- After rodding each layer, tap the sides of the container smartly 10 - 15 times with the mallet
- Strike off the concrete to a smooth surface with the flat strike-off plate
- Clean off all excess concrete and determine the weight of the full container
Unit Weight

- Calculate concrete weight
  - Concrete Weight = Full Weight - Empty Weight
- Calculate the mass per cubic foot of freshly mixed concrete also called unit weight (lbs/ft³)
  - Unit Weight = Concrete Weight / Container Volume

Yield Calculations

- Yield (Y)
  \[ Y_{concrete}(yd^3) = \frac{W_{Load}}{(D \times 27)} \]

- \( W_{Load} \) = total weight of load
- \( D \) = Unit Weight
- 27 = convert units ft³ to yd³
Delivery Tickets

- Contains weight of materials
- Form DT-1756 or equivalent
- Concrete Plant Quality Control Technician’s signature required
- Batch weights may be given on a separate batch ticket

Batching Tolerances

- Individual material weights, when compared to the mix design, must be within the following:
  - Cementitious material: -1% to +4%
  - Aggregates: ±1.5%
  - Water: ±1%
**Delivery Ticket Example**

- See appendix for more examples

**Relative Yield Calculations**

- Relative Yield (Ry)
  
  \[ R_y = \frac{Y}{Y_d} \]

- If Ry > 1.00, an excess of concrete is being produced
- If Ry < 1.00, the batch is “short” of its designed volume
Let’s Review

- Determine the unit weight, yield, and relative yield
  - \( V_{\text{Measure}} = 0.25 \text{ ft}^3 \)
  - \( M_{\text{Measure}} = 7.5 \text{ lbs} \)
  - \( M_{\text{Measure} + \text{Concrete}} = 43.2 \text{ lbs} \)
  - Total weight of load (\( W_{\text{Load}} \)) = 36,000 lbs
  - Design batch (\( Y_d \)) = 9 yd\(^3\)

Solution

- \( M_{\text{Concrete}} = M_{\text{Measure} + \text{Concrete}} - M_{\text{Measure}} = \)

- Unit Weight (\( D \)) = \( \frac{M_{\text{Concrete}}}{V_{\text{Measure}}} = \)

- \( Y_{\text{Concrete}} \) (yd\(^3\)) = \( \frac{W_{\text{Load}}}{(D \times 27)} = \)

- \( R_y = \frac{Y}{Y_d} = \)
Air Content of Freshly Mixed Concrete

By the Pressure Method

AASHTO T 152

ASTM C231
TDOT Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method

References
TDOT Standard Specifications
AASHTO T 152
ASTM C231

Air Content – Pressure Method

• Not to be used for lightweight concrete
• Select a representative sample
• Fill container in three equal layers, slightly overfilling the last layer
• Rod each layer 25 times, uniformly distributing strokes
• Rod the bottom layer throughout its depth without forcibly striking the bottom of the container
Air Content – Pressure Method

- Rod the middle and top layers penetrating about 1” into the underlying layer
- After rodding each layer, tap the sides of the measure smartly 10 - 15 times with the mallet
- Strike off the concrete level with the top of the container using the bar and clean off the rim
- Dampen inside of meter before clamping to base

Air Content – Pressure Method

- Open both petcocks
- Close air valve between air chamber and bowl
- Inject water through one petcock until only water flows out the other petcock
- Continue injecting water into petcock while jarring and tapping the meter to insure that all air is expelled
Air Content – Pressure Method

• Close the air bleeder valve and pump air up to initial pressure line
• Adjust the gauge to the initial pressure by pumping and bleeding as necessary and tapping the gage lightly
• Close both petcocks

Air Content – Pressure Method

• Open the air valve between the chamber and bowl and simultaneously tap the sides of the bowl sharply with the mallet
• Read the air percentage to the nearest 0.1% after lightly tapping the gauge to stabilize the hand
• Close the air valve then open petcocks to release pressure before removing cover
### Table 604.03-1
Composition of Various Classes of Concrete

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

(1) For slip forming, the slump shall range from 0 to 3 inches.
(2) Use Class DS concrete in riding surfaces as described in 903.03 and in accordance to Specification 903.24 requirements. Use Class D concrete in all other bridge decks except box and slab type structures unless otherwise shown on the Plans.
(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.
(4) Water reducing admixtures are acceptable; however, do not exceed the maximum water/cement ratio in order to achieve the required slump.
(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.
(6) The use of fly ash as a cement replacement will be allowed in Class S (Seal) concrete.
(7) Plan specific requirements

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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 _____.
Air Content of Freshly Mixed Concrete

By the Volumetric Method

AASHTO T 196

ASTM C173
TDOT Standard Method of Test for
Air Content of Freshly Mixed
Concrete by the Volumetric Method

References
TDOT Standard Specifications
AASHTO T 196
ASTM C173

Air Content – Volumetric Method

• Can be used on any type of concrete
• Must be used for lightweight concrete
• Fill the bowl in two equal layers
• Rod each layer 25 times
• After rodding each layer, tap the sides of the measure smartly 10 - 15 times with the mallet
• Strike off the concrete flush with the top of the container using the strike-off bar and wipe the flange clean
Air Content – Volumetric Method

- Clamp the top section into position
- Add at least 1 pint of water and the selected amount of alcohol
- Record the number of full pints of alcohol added
- Adjust the water level using a rubber syringe until the bottom of the meniscus is level with the zero mark
- Attach and tighten the water cap

Air Content – Volumetric Method

- Invert and agitate the air meter for a minimum of 45 seconds to free the concrete from the base
  - Do not invert the meter more than 5 seconds at a time
- Roll the air meter for approximately 1 minute with the neck elevated to remove the air from the concrete
- Place the meter upright and loosen the cap to allow any pressure to stabilize
  - The air is considered stable when it does not change by more than 0.25% within a 2-minute period
Air Content – Volumetric Method

- Record air content and repeat rolling process
- Repeat rolling and recording until two consecutive readings do not change by more than 0.25%
- Record final reading to nearest 0.25% and calculate air content
  - Correction factor if more than 2 pints alcohol used
  - Use calibrated cups when air content is greater than 9%
- Air Content = Final Reading – Alcohol Correction Factor + Calibrated Cups

Volumetric Method Correction Factor

<table>
<thead>
<tr>
<th>Pints Used</th>
<th>Correction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>4</td>
<td>0.50</td>
</tr>
<tr>
<td>5</td>
<td>0.75</td>
</tr>
</tbody>
</table>

- Subtract the correction factor from the final meter reading
Air Content – Volumetric Method

Discard test and start over if:
• The third reading changes by more than 0.25%
• Meter leaks
• It takes more than 6 minutes for liquid level to stabilize
• There is more foam than equivalent to 2% air
• Portions of undisturbed concrete found when disassembling meter

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?
Making and Curing Concrete Test
Specimens in the Field

AASHTO T 23

ASTM C31
TDOT Standard Method of Test for
Making and Curing Concrete Test Specimens in the Field

References
TDOT Standard Specifications
AASHTO T 23
ASTM C31

Making Cylinders

• Place molds on a level, rigid, horizontal surface free of vibration
• Fill 6x12 molds in three equal layers (Class CP)
• Fill 4x8 molds in two equal layers
Making Cylinders

<table>
<thead>
<tr>
<th>Cylinder Diameter (in.)</th>
<th>Rod Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6</td>
<td>3/8 ± 1/16</td>
</tr>
<tr>
<td>≥ 6</td>
<td>5/8 ± 1/16</td>
</tr>
</tbody>
</table>

- Rod each layer 25 times with the tamping rod penetrating the previous layer approximately 1”
- Tap the sides of the mold 10-15 times with a mallet
- Strike off the surface with the tamping rod
- Cover cylinders with a non-absorptive cap
Making Cylinders

- Mark the side of the cylinder with the following:
  - Cylinder #
  - Date Made
  - Contract #
  - Date Stripped
  - JJ Sample ID
- Do not etch on the top surface
- Finish cylinders with no depressions or projections larger than $\frac{1}{8}''$
- Store test cylinders on a surface level within $\frac{1}{4}''$ per foot

Curing Cylinders

**Initial Curing**
- Immediately after molding and finishing, store cylinders for a period up to 48 hours in a temperature ranging from 60 - 80°F
- High early strength cylinders (>6000 psi) shall have initial curing temperature between 68 - 78°F

**Final Curing**
- Within 30 minutes of removing from molds, cure cylinders with free water maintained on surface at all times at temperature of 73.5 ± 3.5°F

**Early Break Cylinders**
- Field cure in the same manner and method as placed concrete
Transporting Cylinders

- Cylinders shall not be transported until at least 8 hours after final set
- Transportation time shall not exceed 4 hours
- Protect cylinders 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?
Questions
Self-Consolidating Concrete

(SCC)

AASHTO T 347 / ASTM C1611

AASHTO T 345 / ASTM C1621

ASTM C1758
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.

- U-Box Demo
- Foundation Pour
SCC

- A conventional concrete mix with modified proportions that may use specialized chemical admixtures

### 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)
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)
Aesthetics

Dense Reinforcement
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

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
Terminology and Properties

Workability

• 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

Filling Ability

• The ability of SCC to flow into and fill completely all spaces within the formwork, under its own weight

Passing Ability

• The ease with which concrete can pass among various obstacles and narrow spacing in the formwork without blockage
Terminology and Properties

Stability
  • 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

Dynamic stability
  • The resistance of concrete to the separation of constituents during placement into the formwork

Static stability
  • The resistance of concrete to bleeding, segregation, and surface settlement after casting while the concrete is still in a plastic state
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

Reinforcement Challenges
Concrete Placement

- 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

Field Experience
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

Testing Methods

- **AASHTO T 347/ASTM C 1611**: Slump Flow of SCC
  - Slump Flow
  - VSI (Visual Stability Index)
  - T-50
- **AASHTO T 345/ASTM C 1621**: Passing Ability of SCC by J-Ring
- **ASTM C 1758**: Fabricating SCC Test Specimens
ASTM C1611
Slump Flow, T50, & VSI

- Two procedures:
  - Slump cone upright
  - Slump cone inverted

Apparatus

- Mold
- Base Plate
  - Nonabsorbent, smooth, rigid with a minimum diameter of 36"
  - For T-50, inscribed with concentric circles for the slump cone and one with a 20” diameter
- Strike-off bar
- Stopwatch
- Pouring Vessel
Slump Flow and T-50

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.
**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" 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
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

**Procedure (continued)**

6. Remove the concrete from around the base of the mold
7. Lift the mold vertically to 9 ± 3" in 3 ± 1 seconds with no lateral or torsional motion
8. Wait for the concrete to stop flowing, measure the largest diameter of the spread of concrete to the nearest 0.25". If a halo is present, include with measurement
9. Measure a second diameter approximately perpendicular to the first
Procedure (continued)

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

Example Problems

Example Problem #1

- **Given:**
  - Spread Diameter (1) = 22 inches
  - Spread Diameter (2) = 21.25 inches

- Determine the slump flow.

  $$\text{Slump Flow} = \frac{D_1 + D_2}{2}$$

  $$= \frac{22 + 21.25}{2}$$

  $$= 43.25 / 2$$

  $$= 21.625$$

  **21.50 inches**

Example Problem #2

- **Given:**
  - Spread Diameter (1) = 22.75 inches
  - Spread Diameter (2) = 20.25 inches

- Determine the slump flow.

  $$\text{Slump Flow} = \frac{D_1 + D_2}{2}$$

  $$= \frac{22.75 + 20.25}{2}$$

  $$= 43.00 / 2$$

  $$= 21.50$$

  **WRONG:**

  (Diameters differ more than 2 inches)
**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

**Visual Stability Index (VSI)**

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

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
# VSI

## TABLE X1.1 Visual Stability Index Values

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

- No mortar halo
- No puddles of water

**VSI = 1**

- Slight sheen on the concrete
- False mortar halo caused by excess water on the base plate
VSI = 1

Slight water sheen observed

VSI = 2

Water puddle in concrete patty
Very glossy surface
Mortar halo 0.25” ≤ 0.5”
**VSI = 2**

- Water puddles on concrete patty
- Aggregate pile near the center of patty
- Mortar halo 0.25” ≤ 0.5”

**VSI = 3**

- Water puddles in patty
- Aggregate pile near the center of patty
- Mortar halo greater than 0.5”.
ASTM C1621
Passing Ability by J-Ring

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.
Example Problems

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

Example Problem #2
- Given: Slump Flow = 22.5 inches
  J-Ring Flow = 22.0 inches
  VSI = 0
- Determine the passing ability.

Report the passing ability to the nearest 0.5”

ASTM C1758
Unit Weight, Air Content, and Cylinders

- Applicable for SCC having a slump flow of 20" 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
## 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

### Table 604.03-4: Composition of Self-Consolidating Concrete

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

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 equal to or 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.
**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

**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?
Questions?
Volumetric Concrete

ASTM C685

ACI 304.6R
Volumetric Concrete

References
TDOT Standard Specifications
ASTM C685
ACI 304.6R

Volumetric Concrete

- Concrete materials batched by volume not weight
- Continuous mixing happens as the concrete is poured and placed
- Volumetric mixers, stockpiles, bins, and tanks all fit on a truck making an entire plant portable
Typical Applications

- Volumetric Mobile Mixers lend themselves to a wide variety of applications, which TDOT does not limit.
  - Minor structures – Small Deliveries
  - Mixtures with Short Working Times – Rapid Set
  - Bridge Deck Repairs - Latex-modified overlays (PMC)
  - Remote Sites – Long Haul Times
- Typical Volumetric Mobile Mixers carry enough materials to produce 6 to 10 yd$^3$ of concrete.

Volumetric Specification
(Specification 604.04.B)

- TDOT Specification 604.04.B for volumetric continuous mixers
  - Equipment requirements
  - Calibration/Operation
    - Must be performed by an individual with BOTH certifications:
      - TDOT Concrete Field Testing Technician
      - VMMB Volumetric Mixer Operator
  - Aggregate moisture contents and gradations
    - Must be performed by an individual with Either Certification:
      - TDOT Plant Quality Control Technician
      - TDOT Aggregate Technician
Volumetric Notables

- Each mobile unit considered its own unique producer
- Paperwork to be kept in each mobile unit
  - Process Control Plan
  - Certified Technicians
  - Approved mix designs
  - Materials list
  - Calibration procedure
- Batch/delivery tickets must be signed by VMMB Certified Volumetric Mixer Operator
- Contractor Daily Reports are still required

Calibration and Yield

- Calibrations are done on each material to make sure proportions are correct for:
  - Cement
  - Fine aggregate
  - Coarse aggregate
  - Water
  - Admixtures
- Yield checks are used to verify precise calibration
Volumetric Concrete Video
Appendix

Contacts

• Region 1: Brad Baskette – 865-594-4552
• Region 2: Tony Renfro – 423-510-1190
• Region 3: Kevin Isenberg – 615-350-4312
• Region 4: Mitch Blankenship – 731-935-0215
• HQMT Training Coordinator: Kim Whitby – 615-350-4158; Kimberly.Whitby@tn.gov
Site Manager Support Contacts

- Region 1: Weston Turner – 865-594-0751
  Weston.Turner@tn.gov
- Region 2: Jason Tays – 423-634-7511
  Jason.Tays@tn.gov
- Region 3: Marquitta Primm – 615-217-8902
  Marquitta.Primm@tn.gov
- Region 4: Andrew Webster – 731-935-0358
  Andrew.T.Webster@tn.gov
- HQ Materials and Test: Chris Hampton – 615-626-4519
  C.W.Hampton@tn.gov
- HQ Construction: Grant Heintzman – 615-741-0787
  Grant.Heintzman@tn.gov


AASHTO/ASTM Resources

- Sampling Freshly Mixed Concrete: R 60 / C172
- Temperature of Freshly Mixed Hydraulic-Cement Concrete: T 309 / C1064
- Slump of Hydraulic Cement Concrete: T 119 / C143
- Unit Weight & Yield of Concrete: T 121 / C138
- Air Content of Freshly Mixed Concrete By the Pressure Method: T 152 / C231
- Air Content of Freshly Mixed Concrete By the Volumetric Method: T 196 / C173
- Making & Curing Concrete Test Specimens in the Field: T 23 / C31
- Slump Flow of Self-Consolidating Concrete (SCC): T 347 / C1611
- Passing Ability of SCC by J-Ring: T 345 / C1621
- Fabricating Test Specimens with SCC: C1758
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/

Notables

- Specifications
- Concrete Delivery Ticket Information
- Contractor Daily Report
- Concrete Cylinder Report
- SOP 1-1
- SOP 4-1
- SiteManager Guides
- Batch Ticket Examples
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

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 – 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)

Concrete Pavement 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.

Structural Concrete Haul Times

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.
**CONCRETE DELIVERY TICKET**

Date: ___________________ Ticket # ___________________

Contract # ___________________ County ___________________ Region _______ Load # ___________________

Project # ___________________ Proj. Ref. # ___________________

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

<table>
<thead>
<tr>
<th></th>
<th>ACTUAL</th>
<th>TARGET</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEMENT</td>
<td>lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLYASH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLAG</td>
<td>lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROCK</td>
<td>lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAND</td>
<td>lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATER</td>
<td>gal.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Will accept computer generated equivalent*

Max. water allowed¹ (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.
### CONTRACTOR'S DAILY REPORT OF CONCRETE INSPECTION

**Date**: 

**Contract No.**: 

**Proj. Ref. No.**: 

**County**: 

**Region**: 

**Project**: 

**Contractor**: 

**Sub-Contractor**: 

**Ready Mix Co.**: 

**Location**: 

**Type of Plant Mixer**: 

**Transit Mixer Checked for Presence of Water Before Batching**:  

- [ ] Yes  
- [ ] No  

**Plant and Trucks Checked (Form T-232)**:  

- [ ] Yes  
- [ ] No  

**Approved Process Control Plan**:  

- [ ] Yes  
- [ ] No  

**Date Scales Checked**: 

**Daily Stockpile Check Results**:  

- [ ] Satisfactory  
- [ ] Unsatisfactory  

**W.R.A. / Retarder oz.**:  

**A.E.A. oz.**: 

**Remarks**: 

**Locations Used on Project**: 

**High**  

**Low**  

**Brand or Type of Curing**: 

**Technician Responsible for Cyl.**: 

**Completed by contractor's QC personnel from T-2A Information. Use Attachment A for concrete deck pours.**

#### SCREEN ANALYSIS TOTAL PERCENT PASSING SIEVE

<table>
<thead>
<tr>
<th>Size No.</th>
<th>2&quot;</th>
<th>1 1/2&quot;</th>
<th>1&quot;</th>
<th>3/4&quot;</th>
<th>1/2&quot;</th>
<th>3/8&quot;</th>
<th>#4</th>
<th>#8</th>
<th>#200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size No.</td>
<td>3/8&quot;</td>
<td>#4</td>
<td>#8</td>
<td>#16</td>
<td>#30</td>
<td>#50</td>
<td>#100</td>
<td>#200</td>
<td>F.M.</td>
</tr>
</tbody>
</table>

**Date Tested**: C.A.  

**F.A.**  

**Plant Technician**  

**Cert. No.**

#### DAILY INSPECTION REPORT OF CONCRETE

**Completed by contractor's QC personnel from T-2A information. Use Attachment A for concrete deck pours.**

**Location**

- **Air Temp**: High  
- **Low**  
- **Brand or Type of Curing**
- **Technician Responsible for Cyl.**
- **Average Time in Truck**

**Initial Load Quality Control Test Results at Ready Mix Plant**

<table>
<thead>
<tr>
<th>Slump</th>
<th>% Air</th>
<th>Mix Temp.</th>
<th>Plant Technician</th>
<th>Cert No.</th>
</tr>
</thead>
</table>

**Cylinder No.**  

**Station Made**  

**Slump**  

**% Air**  

**Mix Temp.**  

**Age of Test**  

**Cylinder Made By**

**Ticket Numbers**

**Additional Water Required: Roadway (Gals)**

**Remarks**: 

**Requested by**: 

**Reviewed by**:  

TDOT Project Supervisor or Representative  

**Date**

---

**Item No(s)**

**Report No.**

**Design No.**

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

**Form DT-0311 (Rev. 03-19)**

**69**
# Concrete Cylinder/Core Test Report

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

<table>
<thead>
<tr>
<th>Reference No.</th>
<th>County</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor Placing Concrete</td>
<td>Volume Poured this Date (m$^3$, yd$^3$)</td>
<td></td>
</tr>
<tr>
<td>Daily Report No.</td>
<td>Date of Pour</td>
<td>Requested Age of Test</td>
</tr>
<tr>
<td>Concrete Producer</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Cyl/Core Numbers</td>
<td>Volume Represented by Cyls/Cores (m$^3$, yd$^3$)</td>
<td></td>
</tr>
<tr>
<td>Design Number</td>
<td>Design Strength</td>
<td>Concrete Class</td>
</tr>
<tr>
<td>TDOT Supervisor</td>
<td></td>
<td>Cylinder Curing Data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Number</th>
<th></th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay Quantity/Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity Delivered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sta. of Cyl/Core</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of Pour(s):</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Remarks:</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>Cylinder No. / Core No.</th>
<th>Serial No.</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Date Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compressive Strength (psi)</th>
<th>Ave. Compressive Strength (psi)</th>
<th>Type of Fracture</th>
<th>Perform by</th>
<th>Technician Certification No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cone and Split</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Field Test Data

|--------------------------|---------------|-----------------------------------|-------------------------------|----------------------------|---------------------------------|--------------------------|-------------------------------|

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

<table>
<thead>
<tr>
<th>DIA: + =</th>
<th>DIV BY 2 = AVERAGE =</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>CONDITION OF CYLINDER:</th>
<th>GOOD</th>
<th>FAIR</th>
<th>POOR</th>
</tr>
</thead>
</table>

**CONDITION OF CYLINDER:**

<table>
<thead>
<tr>
<th>COMMENTS:</th>
<th></th>
</tr>
</thead>
</table>

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

---

**Original to:**
- Headquarters Materials and Tests
- Regional Materials and Tests
- Project Supervisor

**Approved by:**
- Director of Materials and Tests

**Date**

**Contractor Observer/Cert. No.**
CONCRETE CYLINDER/CORE TEST REPORT

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

<table>
<thead>
<tr>
<th>Reference No.</th>
<th>County</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor Placing Concrete</td>
<td>Volume Poured this Date (m³, yd³)</td>
<td></td>
</tr>
<tr>
<td>Daily Report No.</td>
<td>Date of Pour</td>
<td>Requested Age of Test</td>
</tr>
<tr>
<td>Concrete Producer</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Cyl./Core Numbers</td>
<td>Volume Represented by Cyls/Cores (m³, yd³)</td>
<td></td>
</tr>
<tr>
<td>Design Number</td>
<td>Design Strength</td>
<td>Concrete Class</td>
</tr>
<tr>
<td>TDOT Supervisor</td>
<td>Unit #</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Pay Quantity/Unit</th>
<th>Quantity Delivered</th>
<th>Sta. of Cyl./Core</th>
<th>Description of Pour(s):</th>
</tr>
</thead>
</table>

Field Test Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Received</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Reported</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter (in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-sectional Area (in²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Load (lbf)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive Strength (psi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ave. Compressive Strength (psi)

<table>
<thead>
<tr>
<th>Type of Fracture</th>
<th>Cone</th>
<th>Cone and Split</th>
<th>Cone and Shear</th>
<th>Shear</th>
<th>Columnar</th>
</tr>
</thead>
</table>

Performed by

Technician Certification 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 -SCC(Rev. 03-19)
<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Material Description</th>
<th>Test</th>
<th>Sampled By</th>
<th>Frequency</th>
<th>Location or Time of Sampling</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASPHALT</td>
<td>Plant Mix Asphalt (Grading A, AS, ACRL, and Asphalt Treated Permeable Base)</td>
<td>Aggregate Gradation: AASHTO T-30 and AASHTO T-11</td>
<td>Project Inspector</td>
<td>Every 1,000 tons</td>
<td>Combined RAP and aggregate bell samples OR Sample completed mix in truck or on roadway.</td>
<td>If testing completed mix, perform extraction using AASHTO T-164 Method E-II utilizing nested sieves (No. 16 and No. 200). AASHTO T-164 Method A may be used for modified asphalt or when problems are encountered filtering according to Method E-II. Not required on production days of less than 100 tons. Ignition oven may be utilized to determine gradation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual Inspection</td>
<td>Small Quantities</td>
<td>Every 1,000 feet</td>
<td>Prior to being overbuild</td>
<td>Refer to Section 313 of the specification for tolerance guidelines.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Placement site</td>
<td></td>
</tr>
<tr>
<td>CONCRETE</td>
<td>Ready Mix, Closure Pour, Grout, Pre-Packaged Mix, Flowable Fill, Prestressed, &amp; Precast</td>
<td>Aggregate Graded, Fractured Face Count, Glassy Particles by mass, Loss on Ignition</td>
<td>Project Inspector or M&amp;T</td>
<td>Every 500 tons for each aggregate size</td>
<td>At source or project site prior to incorporating into work.</td>
<td>Plus No. 4 (4.75 mm) sieve material, gravel mixes only. Plus No. 4 (4.75 mm) sieve material, slag mixes only. From stockpiled materials If blended aggregate, then after blending.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Material Description</th>
<th>Test</th>
<th>Sampled By</th>
<th>Frequency</th>
<th>Location or Time of Sampling</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-Critical Structures</td>
<td>Cylinders (28-day), Slump, Air Content, &amp; Mix Temperature</td>
<td>Project Inspector</td>
<td>Every 25 cubic yards or less weekly</td>
<td>Placement site</td>
<td>Refer to Standard Specification 604.03.</td>
</tr>
<tr>
<td></td>
<td>Class A, A Paving, S, X</td>
<td>Complete set of tests shall be performed on the initial load for informational purposes, not for acceptance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class CP</td>
<td>Cylinders (28-day), Slump, Air Content, &amp; Mix Temperature</td>
<td></td>
<td></td>
<td></td>
<td>Determine depth measurement per Standard Specification 501.24.</td>
</tr>
<tr>
<td></td>
<td>Class D, DS, L</td>
<td>Cylinders (28-day), Slump, Air Content, &amp; Mix Temperature</td>
<td></td>
<td></td>
<td></td>
<td>Refer to SOP 4-1 for acceptance of concrete for bridge decks.</td>
</tr>
<tr>
<td></td>
<td>Class SCC, SH-SCC</td>
<td>Cylinders (28-day), Slumpflow, Air Content, Mix Temperature, Passing Ability by J-Ring, VSI, &amp; T-50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Closure Pour Mix</td>
<td>Cylinders (28-day)</td>
<td></td>
<td></td>
<td>Beginning, middle, and end of the pour</td>
<td>Use limited to 2 cubic yards per day.</td>
</tr>
<tr>
<td></td>
<td>Structural Grout</td>
<td>Cylinders (28-day)</td>
<td></td>
<td></td>
<td></td>
<td>Cylinders required for excavatable only.</td>
</tr>
<tr>
<td></td>
<td>Pre-packaged Mix</td>
<td>Slump, Mix Temperature, &amp; Cylinders (28-day)</td>
<td></td>
<td></td>
<td></td>
<td>Perform additional tests when slump change is apparent or as directed.</td>
</tr>
<tr>
<td></td>
<td>Flowable Fill</td>
<td>Slump, Air Content, and Mix Temperature M&amp;T or Contractor monitored by TDOT personnel</td>
<td></td>
<td></td>
<td>Prestress plant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prestressed Completed Mix</td>
<td>Cylinders (28-Day) for Beams</td>
<td></td>
<td></td>
<td>Beginning, middle and end of the bed</td>
<td>One pair of backup cylinders shall be made.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cylinders (28-Day) for Panels/Piling</td>
<td></td>
<td></td>
<td>Beginning and end of the pour</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cylinders (28-Day) for Tension Release</td>
<td></td>
<td></td>
<td>As needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prestressed Products</td>
<td>Visual Inspection</td>
<td></td>
<td></td>
<td>M&amp;T</td>
<td>Refer to SOP 5-4.</td>
</tr>
<tr>
<td></td>
<td>Precast Products</td>
<td></td>
<td></td>
<td></td>
<td>After casting and before shipment</td>
<td>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 project.</td>
</tr>
</tbody>
</table>

Acceptance by Certification in accordance with SOP 5-3
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.
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°F - 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°F ± 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.
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 5, 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."
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.
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.
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.
### MATERIALS AND PRODUCERS

<table>
<thead>
<tr>
<th>CONCRETE PRODUCER</th>
<th>CEMENTitous MATERIALS</th>
<th>CEMENT</th>
<th>SUPPLEMENTARY CM</th>
<th>TYPE DOMESTIC (TYPE I)</th>
<th>G=3.15</th>
<th>CEMEX - KNOXVILLE</th>
<th>KNOXVILLE, TN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>FLY ASH CLASS F</td>
<td></td>
<td>G=2.55</td>
<td>SEFA GROUP - CUMBERLAND CITY FOSSIL PLANT</td>
<td>CUMBERLAND CITY, TN</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GGBFS, GRADE</td>
<td></td>
<td>G=</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SILICA FUME</td>
<td></td>
<td>G=</td>
<td></td>
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<tr>
<td>AGGREGATE</td>
<td></td>
<td></td>
<td>CRUSH STONE #57</td>
<td>G=2.73</td>
<td>VULCAN MATERIALS - NEWPORT</td>
<td>NEWPORT, TN</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>MANUFACTURED SAND (FM=2.97)</td>
<td>G=2.74</td>
<td>VULCAN MATERIALS - MORRISTOWN</td>
<td>MORRISTOWN, TN</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>NATURAL SAND (FM=0.00)</td>
<td>G=</td>
<td></td>
<td></td>
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<tr>
<td>CHEMICAL ADMIXTURES</td>
<td>BASF</td>
<td>1.</td>
<td>AIR ENTRAINER</td>
<td>MASTERAIR AE 200 (MICRO-AIR)</td>
<td>Retarder to be used when temperature is 85 degrees F or higher.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.</td>
<td>REDUCER</td>
<td>MASTER POLYHEED 900 OR POLYHEED 900</td>
<td>Admixture dosage shall be in accordance with manufacturer's recommendations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.</td>
<td>REDUCER/RETARDER</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>4.</td>
<td>ACCELERATOR</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>5.</td>
<td>HIGH RANGE REDUCER</td>
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<tr>
<td></td>
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<td>6.</td>
<td>OTHER</td>
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</tr>
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</table>

### MIX DESIGN DATA

<table>
<thead>
<tr>
<th>CLASS OF CONCRETE</th>
<th>CLASS A, CONCRETE MIX</th>
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</thead>
<tbody>
<tr>
<td>CEMENT</td>
<td>423</td>
</tr>
<tr>
<td>FLY ASH</td>
<td>141</td>
</tr>
<tr>
<td>GGBFS</td>
<td>1794</td>
</tr>
<tr>
<td>SILICA FUME</td>
<td>1322</td>
</tr>
<tr>
<td>CRUSH STONE #57</td>
<td>254</td>
</tr>
<tr>
<td>NATURAL SAND</td>
<td>1, 2</td>
</tr>
<tr>
<td>MANUFACTURED SAND</td>
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</tr>
<tr>
<td>WATER</td>
<td></td>
</tr>
<tr>
<td>CHEMICAL ADMIXTURES</td>
<td></td>
</tr>
</tbody>
</table>

THEORETICAL UNIT WEIGHT, PCF 145.7
% FA VOLUME OF TOTAL AGGREGATE 42.3
DESIGN W/CM RATIO 0.45
DESIGN AIR CONTENT 6%
REQUIRED COMPRRESSIVE STRENGTH 28 DAYS, PSI 3000
REQUIRED COMPRRESSIVE STRENGTH 28 DAYS, PSI 3000

Remarks:
Design as specified in TDOT Sections 501, 604, 615, 616, 701, 702, 703, 711, or as applicable. Manufactured sand shall not be used in riding surfaces. Mix designs will expire at the end of the calendar year.

Issued By: Headquarters (Materials & Tests)

V36 - TSMR(TSMR) * End of Report *
<table>
<thead>
<tr>
<th>Material</th>
<th>Design Qty</th>
<th>Required</th>
<th>Batched</th>
<th>% Var</th>
<th>% Moisture</th>
<th>Actual Mix</th>
<th>Load ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASESTONE</td>
<td>172.4 lb</td>
<td>125.96 lb</td>
<td>125.29 lb</td>
<td>0.13%</td>
<td>0.2%</td>
<td>3.0%</td>
<td>D12</td>
</tr>
<tr>
<td>SAND</td>
<td>126.2 lb</td>
<td>109.02 lb</td>
<td>108.08 lb</td>
<td>0.12%</td>
<td>0.2%</td>
<td>7.00%</td>
<td>D12</td>
</tr>
<tr>
<td>CEMENT</td>
<td>356.0 lb</td>
<td>320.0 lb</td>
<td>316.0 lb</td>
<td>-1.0%</td>
<td>-1.0%</td>
<td>77.0%</td>
<td>D12</td>
</tr>
<tr>
<td>FLUOR</td>
<td>144.0 lb</td>
<td>67.6 lb</td>
<td>127.0 lb</td>
<td>+25.1%</td>
<td>0.0%</td>
<td>67.0%</td>
<td>D12</td>
</tr>
<tr>
<td>AIR</td>
<td>12.8 oz</td>
<td>14.0 oz</td>
<td>12.0 oz</td>
<td>-6.9%</td>
<td>-6.9%</td>
<td>177.9 oz</td>
<td>D12</td>
</tr>
<tr>
<td>POLYMERIDE</td>
<td>34.0 oz</td>
<td>23.0 oz</td>
<td>23.0 oz</td>
<td>-1.25%</td>
<td>0.0%</td>
<td>177.9 oz</td>
<td>D12</td>
</tr>
<tr>
<td>WATERKIL</td>
<td>38.0 gal</td>
<td>17.0 gal</td>
<td>17.0 gal</td>
<td>0.0%</td>
<td>0.0%</td>
<td>177.9 gal</td>
<td>D12</td>
</tr>
</tbody>
</table>

Actual Mix: 383.7 gal
Predicted Mix: 383.7 gal

Cyl. # 5-A
SLUMP 3.5"
C Temp. 68°
Air Temp. 50°
% Air 6.0%
Material Design Qty Required Batched % Var % Moisture Actual Wt
W0510NE 1734 lb 1813 lb 1814 lb -0.34% 0.39% 81.8 lb
M01-SAND 1520 lb 1520 lb 1520 lb 0.00% 0.00% 81.8 lb
C0000NT 4350 lb 4128 lb 4128 lb -0.48% 0.00% 81.8 lb
FLYASH 1410 lb 1293 lb 1293 lb -0.00% 0.00% 81.8 lb
AIR 6.00 oz 72.00 oz 72.00 oz 0.00% 0.00% 81.8 lb
POLYMER 34.00 oz 385.00 oz 385.00 oz 0.00% 0.00% 81.8 lb
WATERL 30.0 g 187.7 gl 187.7 gl -0.00% 0.00% 81.8 lb

Actual Num Batches: 1
Load Totals: 35709 lb
Design 0.418 Water/Cement 0.431 A
Air Temp 68°

Slump: 4"
Air: 7.8%

STA: 351+33

Concrete Temp: 68°

Air Temp: 48°

26-A

2 in: 1:10

Wayne Ford 9 Dec 2021
39-A
STA-35+33

Slump - 4"
Air Cont - 7.1%
Conc. Temp - 74°
Air Temp - 56°
Driver: 129  
User: 4761  
Disp Ticket Num: 204953  
Ticket ID: 8:17  
Date: 1/8/19

Material | Design Qty | Required | Batched | % Var | % Moisture | Actual Water
----------|------------|----------|---------|-------|------------|-----------------
Concrete  | 1724 lb    | 1622 lb  | 1614 lb | -0.5% | 0.5% | 10 gal
Cement    | 199 lb     | 1290 lb  | 1294 lb | -0.3% | 8.0% | 114 gal
Flashed   | 425.0 lb   | 412.0 lb | 408.0 lb| -1.0% | 8.2% | 119.4 gal
Air       | 6.00 oz    | 21.00 oz | 20.00 oz| 1.25% | 1.0% | 155.0 gal
Water     | 36.0 gal   | 125.5 gal| 105.0 gal| -0.17%| 1.0% | 105.0 gal

Actual.  Num Batches: 1
Load Total: 35621 lb  
Design 0.416 Water/Cement 0.437 A  
Design 270.0 gal  
Actual 278.5 gal  
To Add: 0.0 gal

Slump: 4.00 in  
Water in Truck: 0.0 gal  
Adjust Water: 0.0 gal  
Load Trim Water: 1.0 gal

ln - 8:50
out - 9:30
<table>
<thead>
<tr>
<th>Material</th>
<th>Design Qty</th>
<th>Required Qty</th>
<th>Batched Qty</th>
<th>% Var</th>
<th>% Moisture</th>
<th>Actual Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL</td>
<td>1574 lb</td>
<td>1374 lb</td>
<td>1405 lb</td>
<td>–0.20%</td>
<td>0.50%</td>
<td>3 gl</td>
</tr>
<tr>
<td>CEMENT</td>
<td>450.0 lb</td>
<td>423.0 lb</td>
<td>505.0 lb</td>
<td>+2.0%</td>
<td>0.00%</td>
<td>38 gl</td>
</tr>
<tr>
<td>PLASH</td>
<td>141.0 lb</td>
<td>43.0 l</td>
<td>84.0 l</td>
<td>+5.29%</td>
<td>0.00%</td>
<td>35 gl</td>
</tr>
<tr>
<td>AIR</td>
<td>34.00 oz</td>
<td>15.00 oz</td>
<td>17.00 oz</td>
<td>–5.6%</td>
<td>0.00%</td>
<td>45.00 oz</td>
</tr>
<tr>
<td>POLYMERED</td>
<td>16.00 oz</td>
<td>15.00 oz</td>
<td>15.00 oz</td>
<td>–5.6%</td>
<td>0.00%</td>
<td>15.00 oz</td>
</tr>
<tr>
<td>WATER</td>
<td>30.0 gl</td>
<td>51.6 gl</td>
<td>51.0 gl</td>
<td>–1.46%</td>
<td>0.00%</td>
<td>51.0 gl</td>
</tr>
</tbody>
</table>

Actual Mix Batches: 1

Load Total: 11963 lb

Slump: 4.00 in

Water in Truck: 0.0 gl

Adjust Water: 0.0 gl / Load

Trim Water: 1.0 gl / CY

in - 9:15

out - 10:00