What Every Precaster Should Know About ASTM Standards

Presented by: Sam Lines, Concrete Sealants Inc.

Learning Objectives

• Recognize how a consensus standard is developed and why standards are important
• Dissect the basic organization that is consistent with most ASTM Standards
• Summarize the details of some Standards that are not well know or practiced in the industry

Why Do Standards Matter

• For one, the NPCA Quality Control Manual Requires compliance
• Certified Plants must have the ones they use on file
• They are often required by a contract

About ASTM International

• One of the world’s largest international standards developing organization.
• 30,000 Global Members
• >12,500 Int. Standards
• >140 Countries
• 145 Tech Committees

Committee Structure

• The Technical Committees are divided into seven families
  - (A) Ferrous Metals
  - (B) Non Ferrous Metals
  - (C) Cementitious, Ceramic, Concrete and Masonry Materials
  - (D) Miscellaneous Materials
  - (E) Miscellaneous Subjects
  - (F) Materials for Specific Applications
  - (G) Corrosion, Deterioration and Degradation of Materials

ASTM C1227-13

- Technical Committee
- Standard Number
- Revision Level
How Standards are Developed

• **New**: A Subcommittee will assign a task group to draft the language

• **Revision**: A Subcommittee will form a task group and create a Work Item to draft proposed changes

How Standards are Developed

• **New or Revised Standard is sent to ballot**
  – Subcommittee only
  – Main Committee only
  – Concurrent (sent to main and subcommittee)

• **Ballot is open for 30 days**

• **Membership in the Committee/Subcommittee are able to review and vote**

How Standards are Developed

• Approval of a ballot is by consensus
  – All negatives on a ballot must be resolved

• How a negative can be resolved:
  – A vote in the subcommittee and supported by the main committee to find the negative voter non-persuasive
  – The negative voter can withdraw the negative vote

Standard Lifespan

• A Standard is maintained as active when one of the following happens within five years:
  – A revision is approved by committee ballot
  – A committee ballots a standard for re-approval with no changes
    • Revised standards with no changes have the date in parentheses. Example: C1227-13(18)
    • The standard was re-approved in 2018

Types of ASTM Standards

• **Standard Test Method**
  – a definitive procedure that produces a test result

• **Standard Specification**
  – an explicit set of requirements to be satisfied by a material, product, system, or service

Types of ASTM Standards

• **Standard Practice**
  – an accepted procedure for the performance of one or more operations or functions

• **Standard Guide**
  – a compendium of information or series of options that does not recommend a specific course of action
Form and Style

- A Standard shall be written in mandatory language
  - Use: are, is, must, shall, will, etc.
  - Avoid: could, grant, imply, may, should, would, etc.

Notice

As various Standards are discussed, not every element of every Specification or Test Method will be presented. This course only covers the highlights, and often overlooked portions of the most common Standards in the precast environment.

C143 - Slump

- There are specifications on the apparatus
  - 5.1.1 “Check and record conformance...when it is purchased...and at least annually thereafter.”
- Tamping rod – 5/8” diameter rod, 16” to 24”, at least one hemispherical tip.
  - This is consistent except making 4” x 8” cylinders

C143 - Slump

- Fill in three layers, 1/3 volume each
- Rod each layer 25 times
- After the first layer, rodding will penetrate previous layer by about 1”
- The top layer needs to exceed the volume of the cone.

This procedure is consistent with all conventional concrete tests discussed in this course.
C143 - Slump

- Raise the mold 12” in a steady motion
- Complete this is $5 \pm 2$ seconds
- The entire procedure must be completed in 2 ½ minutes
- Measure from the cone to the displaced center of the sample

C1611 – Slump Flow

- Key Points:
  - No rodding of fill
  - Fill will scoop or a bucket
  - Raise cone steadily 6”-12” in 2 – 4 seconds
  - Complete test in 2 ½ minutes
  - Spread is the average of two perpendicular diameters
  - Record Visual Stability Index (VSI)

Visual Stability Index

Performing the slump flow is one of the first tests in the Quality Control process. Unlike other tests, this concrete may be used for making cylinders or performing other tests. Elevate the spread board on something that allows the board to be higher than the wheelbarrow. When complete, screed the sample back into the wheelbarrow. Remix the concrete. 

Note: Some DOTs will not allow reusing test concrete.
C1064 - Temperature

- Temperature of concrete at time of testing
- Place thermometer in concrete 3”
- Close any voids
- 2 – 5 minutes
- Report to nearest 0.5°

C173 – Air Content (Volumetric)

- All Aggregate types – Must be used for porous or lightweight aggregate
- Reads only the air in the paste
- Add Isopropyl alcohol and make any corrections based on table in Standard

C138 – Density, Yield, Air

- Sometimes called unit weight test
- The bowl from the Air Test (pressure method) is often used
- A volumetric verification of the measure (bowl) is necessary
- The use of a strike off plate is required
- At least ¼” thick, and 2” greater than the diameter of the measure

C138 – Density Calculation

- $D = \frac{(M_c - M_m)}{V_m}$
- Where:
  - $D$ = Density (Unit Weight)
  - $M_c$ = Measure filled with concrete
  - $M_m$ = Measure empty (tare weight)
  - $V_m$ = Volume of the measure
C138 – Density Calculation

- **Tip:**
  - Create a chart for the QC Technician
  - The reading is the measure filled with concrete
  - The density is a calculation

<table>
<thead>
<tr>
<th>Reading (Mc)</th>
<th>Density (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.2</td>
<td>143.7</td>
</tr>
<tr>
<td>40.3</td>
<td>144.1</td>
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<tr>
<td>40.4</td>
<td>144.5</td>
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<tr>
<td>40.5</td>
<td>144.9</td>
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<td>146.1</td>
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<tr>
<td>40.9</td>
<td>146.5</td>
</tr>
<tr>
<td>41.0</td>
<td>146.9</td>
</tr>
</tbody>
</table>

In this example, the Volume of the measure was 0.245 ft³, and it weighs 5 pounds empty.

C138 – Yield Calculation

- The yield can be calculated by:
  \[ Y = \frac{M}{D \times 27} \]
- Where:
  - \( Y \) = the yield in cubic yards
  - \( M \) = The total mass of all materials batched
  - \( D \) = The density of the concrete

C138 – Air Calculation

- The air content can be calculated if the Theoretical Density is known.
  \[ A = \left( \frac{T - D}{T} \right) \times 100 \]
- Where:
  - \( A \) = Air content in the concrete
  - \( T \) = Theoretical density of the concrete computed on an air free basis
  - \( D \) = The density of the concrete

C231 – Air Content (Pressure)

- Is not applicable to concrete made with lightweight aggregate
- Type A and Type B Meters; This course will only focus on Type B meters as shown

C231 – Air Content (Pressure)

- Calibrate as often as necessary, not to exceed three months
- **Aggregate correction factor must be known**
- Prepare the sample as done with C138
- Note: A screed plate must be used if C231 will be performed with C138 sample.

- Close the main air valve, inject water into one petcock until water emerges from the other
- Jar meter until air is expelled from this petcock
- Close the air bleeder valve at this point and pump air into the chamber
- **NOTE: THE PETCOCKS ARE STILL OPEN**
C231 – Air Content (Pressure)

• Pump air until the initial pressure line is reached. Allow some time for the pressure to stabilize, tapping the gauge lightly by hand. Pump or bleed air as necessary.
• Close both petcocks.
• Open the main air valve and tap the side of the measuring bowl “smartly” with mallet.

C231 – Air Content (Pressure)

• Lightly tap the gauge and read the percentage of air on the dial of the pressure gauge.
• Release pressure from both petcocks before removing cover.
• Calculate the air content using this formula:
  \[ A_s = (A_1 - G) \]
  where:
  - \( A_s \) = Air content of the sample
  - \( A_1 \) = the apparent air content
  - \( G \) = Aggregate correction factor

C231 – Air Content (Pressure)

• Method for conventional concrete
• Molds shall be watertight
• Tamping rod – at least 4” greater than mold depth and no greater than 24”
  - < 6” diameter – 3/8” dia. rod
  - ≥ 6” diameter – 5/8” dia. Rod
  - Hemispherical tip on one or both ends

Note: The Concrete used in performing the air content test shall not be used in fabricating test specimens. (Section 8.2)

C31 – Making Concrete Cylinders

• When making cylinders, Slump, Air Content, and Temperature tests shall be conducted.
• Fill concrete in layers:
  - 4” diameter molds – 2 layers
  - 6” diameter molds – 3 layers
• Rod using the appropriate tamping rod 25 times, tapping the mold lightly with mallet or open hand for each layer.

C31 – Making Concrete Cylinders

• Standard curing
  - Store specimens on a surface level within ¼” per ft
  - Initial cure in an environment preventing moisture loss at 60° to 80° for up to 48h
    - 6,000 psi or greater concrete at 68° to 78°
  - Final cure specimens with free water maintained on their surface at a temperature of 70° to 77° within 30 minutes of removing them from molds.
C31 – Making Concrete Cylinders

• Field curing
  – Store cylinders in an environment as close to the product as possible.
  – Provide the cylinders with the same temperature and moisture as the concrete product.
  – Remove cylinders from molds when concrete product is removed from the forms.

C31 – Making Concrete Cylinders

• Use Standard curing for:
  – Acceptance testing for specified strength
  – Checking adequacy of mixture proportions
  – Quality Control

• Use field curing for:
  – Determining when to place a product in service
  – As a comparison with standard curing
  – To determine adequacy of curing
  – For determining form removal

NPCA QC Manual
Section 5.3.5.1 for Wet Cast
“Compressive strength cylinders shall be made in accordance with ASTM C31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field.” Specimens shall be cured in a manner similar to the curing of the concrete products represented by the specimens, unless otherwise required by the project.”

C1758 – Making SCC Cylinders

• For concrete having a slump flow of 20” or greater.
• Fill the mold in one lift
• Do not rod or tamp the mold
• Follow the C31 Specifications for curing and handling.

C39 – Concrete Strength Testing

• Individual performing test shall meet the concrete laboratory technician requirements of Practice C1077
• The following are accepted:
  – ACI Concrete Laboratory Technician, or
  – ACI Concrete strength Testing Technician

C39 – Concrete Strength Testing

• Testing machine
  – Calibrated within the loading ranges used
  – Calibrated when:
    • Originally installed;
    • Immediately after relocation;
    • Immediately after making repairs or adjustments
    • Within 13 months of last calibration
  – Clean and lubricate the curved surfaces of the socket at least every six months
C39 – Concrete Strength Testing

- Test Specimens shall be kept moist until tested.
- Test cylinders at the desired age:
  - 24h ± 0.5h
  - 3 days ± 2h
  - 7 days ± 6h
  - 28 days ± 20h
  - 90 days ± 2 days

C39 – Concrete Strength Testing

- Loading rate:
  - Load at a rate of 35 ± 7 psi per second
  - During application of the first half of the anticipated loading phase, a higher loading rate shall be permitted.
  - Maintain the controlled rate of compression for the second half of the loading phase.

C39 – Concrete Strength Testing

- Record the maximum load and the fracture type.
- Calculate the compressive strength by dividing the maximum load carried by the average cross-sectional area of the cylinder surface.
  - 4” diameter = 12.57 in²
  - 6” diameter = 28.27 in²

Type 1: Rosetten with web-furred cone or both ends, less than 1.6 x 0.5 area of cracking through cap
Type 2: Web-furred cone on one end, vertical cracks moving through cap, no web-furred cone on other end
Type 3: Columnar crack at top or bottom of cylinder or parallel to 45° line Type 4: Digital fracture with no cracking through ends, tip with transverse web-furred cone
Type 5: Slab fracture at top or bottom (or parallel to 45° line) with undefined cracks
Type 6: Similar to Type 3 but end of cylinder is parallel
C805 – Rebound Hammer

- Used to assess the in-place uniformity of concrete.
- Not suitable as the basis for acceptance or rejection of concrete.
- Correlation to a known concrete core strength is required.

C1227 – Precast Septic Tanks

- This is a Standard Specification for the design, manufacture and performance of a septic tank.
- Under the jurisdiction of ASTM Committee C27 and subcommittee C27.30

C1227 – Precast Septic Tanks

- Ordering Information
- Materials and Manufacture
- Structural Design Requirements
- Physical Design Requirements
- Quality Control and Sampling
- Repairs
- Rejection
- Product Marking

C1227 – Precast Septic Tanks

- Performance Test Methods
  - Proof testing to demonstrate tank strength
  - 150% of the anticipated loads

C1227 – Precast Septic Tanks

- Top Loads
  - (325 psf) x 150% = 488 psf
- Floor Loads
  - (500 psf) x 150% = 750 psf
- Wall Loads
  - (220 psf) x 150% = 330 psf

With a concentrated wheel load of 2,250 pounds

Since the floor load is the highest load force, it can be used for vacuum testing.

750 psf = 10.4” Mercury
Precast Septic Tanks

- Watertight testing
  - Vacuum (Negative Pressure)
    - -4” of Mercury (Hg) for 5 minutes, no loss
  - Water Test
    - Fill tank with water, let stand for 24h
    - Refill tank. Tank is approved if water level does not drop after one hour.

Pipe & Manhole Testing

- Three Edge Bearing Test
- Flat Slab Top Test
- Core Strength Test
- Absorption Test
- Hydrostatic Test
- Permeability Test
- Manhole Step Test

C497 – Pipe & Manhole Testing

- Cylinder Strength Test
- Gasket Lubricant Test
- Joint Shear Test
- Alkalinity of Concrete Mixture Test
- Measurement of Rubber Gasket Volume and Dimensions
- Off-Center Hydrostatic

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