ASTM C31

Standard Practice for Making and Curing Concrete Test Specimens in the Field

Understanding ASTM International Test Procedures for Cement and Concrete - Staying Up to Standard

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Acknowledgments

Slides Adapted from ASTM International

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Outline

- Objectives
- Related Procedures
- Scope/Significance and Use
- Identify Necessary Equipment
- Measure Properties of Specimens
- Procedure
- Reporting and Failure Modes

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Related Procedures

- ASTM C470 – Specification for Molds for Forming Concrete Test Cylinders Vertically
- ASTM C143 – Test Method for Slump of Hydraulic-Cement Concrete
- ASTM C172 – Practice for Sampling Freshly Mixed Concrete
- ASTM C173 – Test Method for Air Content of Freshly Mixed Concrete by Pressure Method
- ASTM C138 – Test Method for Density (Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- ASTM C1064 – Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

Scope/Significance and Use

- ***Scope:*** This practice covers procedures for making and curing cylinder and beam specimens from representative samples of fresh concrete for a construction project.
- ***Significance and Use:*** This practice provides standardized requirements for making, curing, protecting, and transporting concrete test specimens under field conditions.

Apparatus: Molds

- Anything nonabsorbent and nonreactive with portland and other hydraulic cements.
- Cylinder molds covered by ASTM C470
- Beam molds: Shall be,
  - smooth, straight, and free from warping
  - at right angles to each other
- Maximum variation from nominal dimensions shall be ≤ 3 mm for molds with a cross sectional dimension of 150 mm or greater.
- Length shall not be more than 2 mm shorter than that specified in Section 6.2.

Apparatus: Consolidation

- Tamping rod
  - 10 mm diameter for 150 mm specimens
  - 16 mm diameter for 150 mm and larger specimens
  - Rounded tip (to same diameter as rod)
- Vibrator
  - Internal vibrator with a frequency of 150 hz.
  - Diameter ≤ ¼ diameter of cylinder or ¼ width of beam mold
- Mallet
  - 0.6 kg rubber or raw hide mallet

Apparatus: Placement and Finishing

- Placement
  - Scoops for cylinders
  - Scoops or shovels for beams
  - Large enough for a representative sample but small enough to avoid spilling
- Finishing
  - Handheld float or trowel

Apparatus: Sampling and Fresh Properties

- Sampling
  - Large pan, wheel barrow, or flat (clean and non-absorbant) board large enough for remixing the material with a trowel or shovel
- Slump – ASTM C143
- Air Content – ASTM C173 or C231
- Temperature – ASTM C1064

Test Requirements – Cylinders

- Shall be cast and allowed to set in an upright position.
- Mold Diameter ≥ (3 x NMS)
  - NMS = Nominal Maximum Size of the coarse aggregate
- Mold Height = (2 x Diameter)

Test Requirements – Cylinders

- For acceptance testing, molds can be either
  - 150 x 300 mm

  or
  - 100 x 200 mm size.

Test Requirements – Cylinders

- When the NMS of the coarse aggregate is greater than 50 mm, wet sieve the concrete over a 50 mm sieve.
- The specifier of the tests shall establish the number and size of the specimens to be cast.

Test Requirements – Cylinders

- Based on the mold diameter and wet sieveing requirements, the following can be inferred from the standard
  - 100 mm diameter cylinders can be usted only when the NMS of the coarse aggregate is ≤4/3-inch
  - 150 mm diameter cylinders can be used when the NMS of the coarse aggregate is ≤ 50 mm or when the concrete is wet sieved over a 50 mm sieve

Test Requirements – Beams

- Shall be cast and allowed to set in an horizontal position.
- Width : Depth ≤ 1.5 : 1
- Mold Length ≥ (3 x Mold Depth) + 50 mm
- The specifier of the tests shall establish the number of the specimens to be cast.
- Standard size is 150 x 150 mm

Test Requirements – Beams(sec 6.2)

- Standard mold shall be used for concretes with a nominal maximum size (NMS) of coarse aggregate ≤ 50 mm.
- When the NMS of the aggregate is >50mm, the smaller cross sectional dimension shall be ≥ (3 x NMS).
- Unless specified otherwise, molds shall not be less than 150 mm in width or depth.

Casting Cylinders

- Unless otherwise specified, determine the method of consolidation from Table 2.
- Depending on the method of consolidation, determine the molding requirements from Table 3 or Table 4.

Tables 1, 3 and 4

- For 100 mm diameter cylinders:

Rodding	Vibration
10 mm rod	≤ 25 mm shaft
2 layers	2 layers
25 roddings per layer	1 insertions per layer

Tables 1, 3 and 4

- For 6 inch diameter cylinders:

Rodding	Vibration
16 mm rod	≤ 38 mm shaft
3 layers	2 layers
25 roddings per layer	3 insertions per layer

Casting Cylinders

- Use a scoop to place concrete in the mold.
- Move the scoop around the mold opening so material is evenly distributed and segregation is minimized.
- When placing the final layer, add enough concrete so that the mold is full after consolidation.
- Consolidate each layer of concrete.

Casting Beams (9.3)

- Unless otherwise specified, determine the method of consolidation from Table 2.
- Depending on the method of consolidation, determine the molding requirements from Table 3 or Table 4.

Tables 1, 3 and 4

- For beams 150 to 200 mm wide:

Rodding	Vibration
16 mm rod	≤ 10 mm shaft
2 layers	1 layer
1 per each 50 mm^2 of top surface area	insert at a spacing ≤ 150 mm

Casting Beams

- Use a scoop or shovel to place concrete in the mold.
- Move the scoop around the mold opening so material is evenly distributed and segregation is minimized.
- When placing the final layer, add enough concrete so that the mold is full after consolidation.
- Consolidate each layer of concrete.

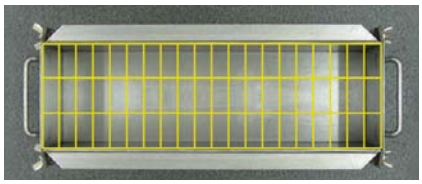
Rodding - Cylinders

- Fill molds in layers of approximately equal volume.
- Rod each layer 25 times.
  - uniformly distribute the rodding strokes over the cross section of the mold
  - rod the bottom layer through its depth
  - rod each upper layer through its depth and into the layer below approximately 25 mm

Rodding - Beams

- Fill molds in layers of approximately equal volume.
- Rod each layer once per each 50 mm^2 of top surface area.
  - uniformly distribute the rodding strokes over the cross section of the mold
  - rod the bottom layer through its depth
  - rod the upper layer through its depth and into the layer below approximately 25 mm

Rodding (9.4.1)



For a 150 mm by 508 mm beam, rod each layer 60 times [(6x20)/2=60].

Rodding (9.4.1)

- After rodding a layer, tap the outside of the mold lightly 10 to 15 times with a mallet.
  - close holes left by the rod and release large air bubbles
  - Cylinders - use an open hand when light-gage single-use cylinder molds could be damaged by the mallet
- Beams - Spade each layer along the sides and ends of the beam.
  - use a trowel or other suitable device

Spade Along Sides and Ends

Rodding (9.4.1)

- During consolidation of the top layer, use representative concrete to adjust underfilled molds.
- Remove excess concrete from overfilled molds.

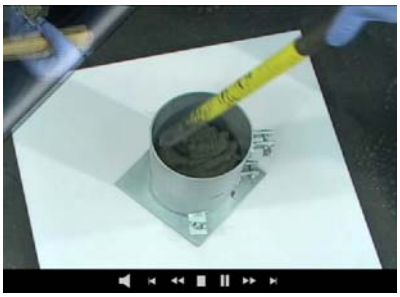
Vibration (9.4.2)

- Fill the mold in a single layer (BEAMS) or 2 layers (CYLINDERS).
- Add all material for the layer before vibrating the layer.
- Insert the vibrator per Table 4.
  - insert along the centerline of the long dimension of the mold at a spacing ≤ 6 inches
  - vibrate the layer through its depth

Vibration (9.4.2)

- After vibrating the layer, tap the outside of the mold sharply at least 10 times with a mallet.
  - close holes that remain and release entrapped air voids
  - use an open hand when light-gage single-use cylinder molds could be damaged by the mallet

Vibration (9.4.2, 9.4.2.2)



Vibration (9.4.2)

Finishing (9.5.1)

- Strike off the top surface with a tamping rod, handheld float or trowel.
- If desired, cap the cylinder with a layer of stiff portland cement paste.

Finishing (9.5.2)

- Strike off the top surface with a handheld float or trowel to produce a flat, even surface.

Curing (10.1.1-10.1.3)

- Follow the common storage, initial curing and final curing procedures outlined in Sections 10.1.1, 10.1.2 and 10.1.3.
  - Within 30 minutes of removal from the mold cure specimens with free water on the surface at all times and at a temperature of 23±3°C in water storage tanks or moist room (complying with ASTM C511) except when preparing specimens for testing.

Final Curing (10.1.3.1) - Cylinders

- Standard curing temperatures are not required,
  - for up to 3 hrs immediately prior to testing
  - if free moisture is maintained on the cylinders
  - if the ambient temperature remains between 20 and 30 °C
- When capping with sulfur mortar, dry the ends of the specimen to prevent the formation of steam or foam pockets.

Field Curing (10.2.1) - cylinders

- Test specimens in the moisture condition that results from the specimen being cured in the field.
- Specimens made for determining when a structure can be put in service shall be removed from their molds when formwork is removed from the structure.

Field Curing (10.2.2) – beams

- As much as possible, cure beam specimens in a manner similar to that of the structure.
- After 48 ± 4 hrs of curing,
  - move beams to the storage location
  - remove beams from their molds

Field Curing (10.2.2) – Beams

- For pavements and slabs on grade,
  - place molded beams on the ground with the top surface facing up
  - bank the sides and ends of the mold with earth or sand that is kept moist
  - leave the top surface exposed to the specified curing treatment

Beams (10.2.2)

- For structures,
  - store molded beams near the point where the concrete was placed in the structure
  - provide the same temperature and moisture environment as for the structure
  - at the end of curing, leave the beams in place and exposed them to the same environmental conditions as the structure

Field Curing (10.2.2) – beams

- Immediately prior to testing,
  - remove beams from field storage
  - for 24 ± 4 hours prior to testing, beams shall be stored in water saturated with calcium hydroxide (lime) at a temperature of 23 ± 2 °C
  - prevent drying of the beam surfaces from the time of removal from the water storage through the completion of testing

Questions & Answers