

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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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 \leq 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.

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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 \leq $\frac{1}{4}$ diameter of cylinder or $\frac{1}{4}$ width of beam mold
- ▶ Mallet
 - 0.6 kg rubber or raw hide mallet

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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

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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

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Test Requirements – Cylinders

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

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Test Requirements – Cylinders

- ▶ For acceptance testing, molds can be either
 - 150 x 300 mmor
 - 100 x 200 mm size.



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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.



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Test Requirements – Cylinders

- ▶ Based on the mold diameter and wet sieving requirements, the following can be inferred from the standard
 - 100 mm diameter cylinders can be used only when the NMS of the coarse aggregate is $\leq 4/3$ -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

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Test Requirements – Beams

- ▶ Shall be cast and allowed to set in an horizontal position.
- ▶ Width : Depth $\leq 1.5 : 1$
- ▶ Mold Length $\geq (3 \times \text{Mold Depth}) + 50 \text{ mm}$
- ▶ The specifier of the tests shall establish the number of the specimens to be cast.
- ▶ Standard size is 150 x 150 mm



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Test Requirements – Beams(sec 6.2)

- ▶ Standard mold shall be used for concretes with a nominal maximum size (NMS) of coarse aggregate $\leq 50 \text{ mm}$.
- ▶ When the NMS of the aggregate is $>50\text{mm}$, the smaller cross sectional dimension shall be $\geq (3 \times \text{NMS})$.
- ▶ Unless specified otherwise, molds shall not be less than 150 mm in width or depth.



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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.

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Tables 1, 3 and 4

- ▶ For 100 mm diameter cylinders:

Rodding	Vibration
10 mm rod	≤ <u>25 mm</u> shaft
<u>2</u> layers	2 layers
25 roddings per layer	<u>1</u> insertions per layer

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Tables 1, 3 and 4

- ▶ For 6 inch diameter cylinders:

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

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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.

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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.

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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

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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.

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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

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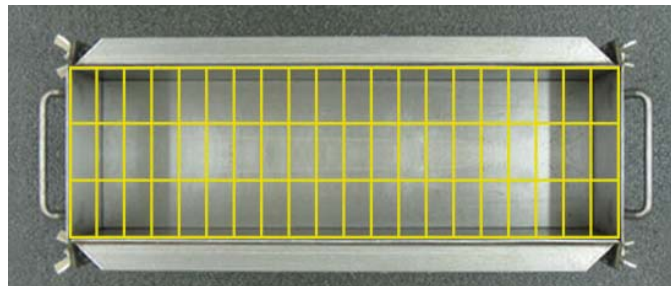
Rodding - Beams

- ▶ Fill molds in layers of approximately equal volume.
- ▶ Rod each layer once per each 50 mm² 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

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Rodding (9.4.1)



For a 150 mm by 508 mm beam, rod each layer 60 times $[(6 \times 20) / 2 = 60]$.

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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

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Spade Along Sides and Ends



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Rodding (9.4.1)

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

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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 \leq 6 inches
 - vibrate the layer through its depth

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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

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Vibration (9.4.2, 9.4.2.2)



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Vibration (9.4.2)



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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.



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Finishing (9.5.2)

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



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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 $23\pm 3^{\circ}\text{C}$ in water storage tanks or moist room (complying with ASTM C511) except when preparing specimens for testing.

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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.

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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.

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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

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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

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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

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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

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Questions & Answers