Tex-447-A, Making and Curing Concrete Test Specimens

Contents:

Section 1

Overview

Effective dates: December 2004–June 2008.

This test method covers procedures for making and curing cylindrical and prismatic concrete specimens that can be consolidated by rodding or vibration as described herein. 'Part I, Compressive Strength Specimens (Cylinders)' addresses cylindrical specimens and 'Part II, Flexure Strength Specimens (Beams)' addresses prismatic specimens. Except for provisions for curing at remote sites, this test method conforms to ASTM C 31, AASHTO T 23, ASTM C 192 and AASHTO T 126.

Units of Measurement

The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

Section 2

Part I, Compressive Strength Specimens (Cylinders)

This part covers procedures for making and curing cylindrical concrete specimens.

Apparatus

The following apparatus is required:

- vibrator
  - with rigid or flexible shafts, preferably powered by electric motors, vibrating at a frequency of 7,000 vibrations per minute or greater, with the outside diameter or side dimension of the vibrating elements at least 3/4 in. (19 mm), and not greater than 1/4 the diameter of the specimen
  - combined length of the shaft and vibrating element exceeding the maximum depth of the section being vibrated by a minimum of 3 in. (75 mm)
  - vibrating-reed tachometer for vibration frequency verification.
- tamping rods
  - one 5/8 in. (16 mm) in diameter and approximately 20 in. (500 mm) long
  - the other 3/8 in. (10 mm) in diameter and approximately 12 in. (300 mm) long
  - of round, straight steel, with the tamping end rounded to a hemispherical tip the same diameter as the rod.
- small tools, such as shovels, pails, trowels, wood float, scoops, and rubber gloves
- mallet, with a rubber or rawhide head, weighing 1.25 ±0.50 lb. (0.6 ±0.2 kg)
- burlap or cotton mats
- storage tank, or moist room, as specified in 'Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cement and Concrete'
- molds
  - Molds must be water tight, circular cylinders made of steel, cast iron, or other non-absorbent material, nonreactive with concrete containing portland or other hydraulic cements.
  - Provide either single-use molds or reusable molds. Single-use molds and caps are made of molded polyethylene or plastic designed to be used a single time. Reusable molds are constructed from a rigid material and designed to be used more than a single time.
  - The molds must stand with cylindrical axes vertical and the top open, with a nominal inside height equal to twice the nominal inside diameter.

- The average diameter must not differ from the nominal diameter by more than 1% and no diameter of a mold must differ from any other diameter of the same mold by more than 2%.
- The average height must not differ from the nominal height by more than 2%.
- The planes of the top rim of the mold and the bottom should be perpendicular to the axis of the mold within 0.5° (approximately equivalent to 1/8 in. in 12 in. [3 mm in 300 mm]).
- Do not use paper, cardboard, or sheet metal molds.
- Measure a representative sample of each shipment of molds for roundness on the open end of the mold; use 2 diameters measured at right angles to each other to determine compliance to the tolerances stated above. Do not use molds that do not meet these tolerances.
- Reject molds, which are not sufficiently strong and tough to allow use under normal construction conditions without tearing, crushing, or otherwise deforming when filled with fresh concrete.
- Use a snap-on locking plastic cap with the mold to prevent water loss and add rigidity.
- Do not store caps inside cylinder molds before use.
- Provide molds with a closure or base on the lower end at right angles to the axis of the cylinder.
- Use a suitable sealant, such as heavy grease or molding clay, where necessary to prevent leakage through the joints of the assembled mold.

NOTE: Satisfactory reusable molds can be made from lengths of tubing or pipe slit on one side parallel to the axis, fitted with a means to close the vertical slit as well as to attach a base plate. Maintain required dimensional tolerance after slitting, clamping and attaching the base plate.

♦ Cover plates or caps made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. A 5 × 5 in. (125 × 125 mm) plate for 4-in. (100-mm) molds and an 8 × 8-in. (200 × 200-mm) plate for 6-in. (150-mm) molds will be adequate.

Test Specimens

Below are the requirements for standard test specimens:

♦ The standard specimens may be 6 × 12-in. (150 × 300-mm) or 4 × 8-in. (100 × 200-mm) cylinders. The diameter of the specimen must be at least 3 times the nominal maximum size of coarse aggregate in the concrete. Do not use molds of 4 in. (100 mm) when more than 5% of the design coarse aggregate content is larger than 1-1/2 in. (37.5 mm).

♦ The specimens are subject to the same tolerances as the molds.

Sampling

Sample freshly mixed concrete according to "Tex-407-A, Sampling Freshly Mixed Concrete." Remove all particles of aggregate larger than 2 in. (50 mm) in size.

NOTE: ASTM requires removal of coarse aggregate larger than 2 in. (50 mm) by wet sieving. The department allows removal of the larger aggregate by hand.

Molding Test Specimens

The following table describes the procedure for molding test specimens.

Molding Concrete Test Specimens	
Step	**Action**
1	♦ Mold specimens promptly on a level, rigid, horizontal surface, free from vibration and other disturbances, at a place as near as practical to the location where they are to be stored during the first 24 hr. ♦ If it is not practicable to mold the specimens where they are to be stored, move them to the place of storage immediately after striking off. ♦ When moving specimens made in single use molds, lift and support the specimens from the bottom of the molds with a large trowel or other flat device.
2	♦ Place the concrete in the molds using a scoop or shovel, in layers of approximately equal volume. ♦ Move the scoop around the top edge of the mold as the concrete is discharged to ensure a symmetrical distribution of the concrete and minimize segregation of the coarse aggregate within the mold. ♦ In placing the final layer, try to add an amount of concrete that will exactly fill the mold after compaction. ♦ Do not add nonrepresentative concrete to an under-filled mold.

Consolidation

Described below are the methods of consolidation.

Preparing of satisfactory specimens requires 2 different methods of consolidation - rodding and vibration.

Base the method of consolidation on the slump, unless stated in the specifications under which the work is being performed.

Rod concrete with a slump greater than 3 in. (75 mm).

Rod or vibrate concrete with a slump of 1 to 3 in. (25 to 75 mm).

Vibrate concrete with a slump of less than 1 in. (25 mm).

♦ Rodding:

- Form a 6 × 12 in. (150 × 300 mm) test cylinder by placing concrete in the mold in 3 layers of approximately equal volume. Form a 4 × 8-in. (100 × 200-mm) test

cylinder by placing concrete in the mold in 2 layers of approximately equal volume.

- In placing each scoopful of concrete move the scoop around the top edge of the mold as the concrete slides from it to prevent segregation of the particles and to secure a uniform distribution of concrete in each layer.
- Rod each layer 25 times with the rounded end of the tamping rod, distributing the strokes uniformly over the cross section of the mold. For 6 × 12-in. (150 × 300-mm) test cylinders, use a 5/8-in. (16-mm) rod. For 4 × 8-in. (100 × 200-mm) test cylinders, use a 3/8-in. (10-mm) rod.
- Rod each layer using only enough force to cause the rod to penetrate slightly into the underlying layer.
- After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with the mallet to close any holes left by rodding and to release any large trapped air bubbles.
- Use an open hand to tap single-use molds, which are susceptible to damage if tapped with a mallet.

♦ Vibration:

- Place concrete in the mold in 2 layers.
- For 6 × 12 in. (150 × 300 mm) test cylinders, use 2 insertions of the vibrator at different points for each layer. For 4 × 8 in. (100 × 200 mm) test cylinders, use 1 insertion of the vibrator for each layer.
- Do not allow the vibrator to rest on or touch the bottom or sides of the mold.
- Carefully withdraw the vibrator in such a manner to keep air pockets left in the specimen to a minimum.
- Allow vibrator to penetrate the top layer and into the bottom layer approximately 1 in. (25 mm).
- After vibrating the layer, tap the outside of the mold lightly 10 to 15 times with the mallet to close any holes that remain and to release trapped air bubbles.
- Use an open hand to tap light-gage single use molds, which are susceptible to damage if tapped with a mallet.

After consolidation, strike off the surface of the concrete and float or trowel as required. Perform all finishing with the minimum manipulation necessary to produce a flat even surface level with the rim or edge of the mold that has no depressions or projections larger than 1/8 in. (3.3 mm).

Curing Specimens

Described below are the requirements for curing specimens at the jobsite and in the laboratory:

♦ Jobsite

Immediately after finishing, take precautions to prevent evaporation and loss of water from the specimens.

Curing Specimens at the Jobsite

Step	Action
1	Cover the specimens with a nonabsorbent, nonreactive plate or sheet of impervious plastic. ♦ Wet burlap or cotton mats may be used over the plate or plastic sheet to help retard evaporation, but the burlap or cotton mats must not touch the surface of the concrete. ♦ Keep the covering thoroughly saturated until removal of the cylinders from the molds. *NOTE*: Storage conditions during the first 48 hr. have an important influence on the strength developed in concrete.
2	Store test specimens under conditions that prevent loss of moisture and where the temperature range is 60 to 80°F (16 to 27°C).
3	Within 24 to 48 hr. after making the specimen, transport the specimen in the mold to the location of the jobsite curing tank.
4	Remove the mold being careful not to damage the test specimen.
5	Place the specimen in the curing tank and keep immersed in saturated limewater maintained at a temperature of 60 to 80°F (16 to 27°C). Do not expose the specimens to a stream of flowing water.
6	Cure test specimens representing tests for removal of forms and/or false work using the same methods as the concrete represented at the jobsite for at least 4 days after casting before transporting to the laboratory for testing.
7	When shipping to the laboratory, carefully wrap the specimens in wet paper and secure in wet burlap or seal in a plastic bag.

♦ Laboratory

- Immediately after forming the test specimen cover the mold with the cover plate and allow the specimen to sit undisturbed for at least 24 hr.
- Then remove the mold and place the cylinder in the moist room to cure under conditions of controlled temperature of 73.5 ±3.5°F (23 ±2.0°C) and a relative humidity of not less than 95% for the specified time.

Section 3

Part II, Flexure Strength Specimens (Beams)

This section covers procedures for making and curing prismatic concrete specimens.

Apparatus

The following apparatus is required:

- beam molds
  - must be made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements.
  - must hold their dimensions and shape under severe use. Molds must be watertight. Use a suitable sealant, such as heavy grease, modeling clay or micro-crystalline wax where necessary to prevent leakage through the joints.
  - lightly coated with mineral oil or a suitable non-reactive release material before use.
  - must be rectangular in shape with 6 × 6 × 20 in. (150 × 150 × 508 mm) nominal dimensions.
  - must have smooth inside surfaces, free from blemishes.
  - sides, bottom, and ends must be at right angles to each other and must be straight, true, and free of warpage. Maximum variation from the nominal cross-section not exceeding 1/8 in. (3 mm).
  - must not be more than 1/16 in. (2 mm) shorter than the nominal length, but may exceed it by more than that amount.
- tamping rod, a straight steel rod 5/8 in. (16 mm) in diameter and approximately 20 in. (500 mm) in length with one end rounded to a 5/8 in. (16 mm) diameter hemispherical tip
- vibrator, as described in 'Part I, Compressive Strength Specimens (Cylinders)'
- small tools, as in Part I, plus blunted trowels, and straightedge
- mallet, as in Part I
- burlap or cotton mats
- storage tank, or moist room, as specified in 'Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cement and Concrete.'

Test Specimens

Below are the requirements for flexural strength test specimens:

Flexural strength specimens must be rectangular beams of concrete cast and hardened with the long axis horizontal.

Unless the project specifications require another size, test beams must be 6 × 6 × 20 in. (150 × 150 × 508 mm) subject to the same tolerances as for molds.

All surfaces must be smooth and free of scars, indentations, holes, or inscribed identifications.

Sampling

Sample freshly mixed concrete according to "Tex-407-A, Sampling Freshly Mixed Concrete." Remove all aggregate particles larger than 2 in. (50 mm).

NOTE: ASTM requires removing coarse aggregate larger than 2 in. (50 mm) by wet sieving. The department allows removal of the larger aggregate by hand.

Molding Test Specimens

The following table describes the procedure for molding test specimens:

Molding Concrete Test Specimens

Step	Action
1	♦ Mold specimens promptly on a level, rigid, horizontal surface, free from vibration and other disturbances, at a place as near as practicable to the location where they are to be stored during the first 24 hr. ♦ If it is not practicable to mold the specimens where they are to be stored, move them to the place of storage immediately after strike off. ♦ Avoid jarring, striking, tilting, or scarring of the surface of the specimens when moving the specimens.
2	♦ Place the concrete in the molds using a scoop or shovel, in layers of approximately equal volume. ♦ Move the scoop around the top edge of the mold as the concrete is discharged to ensure a symmetrical distribution of the concrete and minimize segregation of the coarse aggregate within the mold. ♦ In placing the final layer, try to add an amount of concrete that will exactly fill the mold after compaction. ♦ Do not add nonrepresentative concrete to an under-filled mold.

Consolidation and Finishing

Described below are the requirements for consolidating and finishing the concrete:

Base the method of consolidation on the slump, unless stated in the specifications under which the work is being performed.

Rod concrete with a slump greater than 3 in. (75 mm).

Rod or vibrate concrete with a slump of 1 to 3 in. (25 to 75 mm).

Vibrate concrete with a slump of less than 1 in. (25 mm).

- Rodding:
  - Place concrete in mold in 2 layers.
  - Rod each layer with the rounded end of rod.
  - Rod each layer of a beam one time for each 2 $in.^2$ (14 cm^2). Use 60 strokes for a 6 × 6 × 20-in. (150 × 150 × 508-mm) beam.
  - Rod the bottom layer throughout its depth.
  - Distribute the strokes uniformly over the cross-section of the mold.
  - For the upper layer, allow rod to penetrate about 1 in. (25 mm) into the underlying layer.
  - After each layer is rodded, tap the outside of the mold lightly 10 to 15 times with the mallet to close holes left by rodding and to release trapped air bubbles.
  - After tapping, spade the concrete along the sides and ends of mold with a trowel or other suitable tool.
- Vibration:
  - Place concrete in mold in one layer.
  - Insert vibrator at intervals not exceeding 6 in. (150 mm) along the centerline of the long dimension of the specimen.

NOTE: Do not allow vibrator to rest on or touch bottom or sides of the mold.

  - Carefully withdraw the vibrator to keep air pockets left in the specimen to a minimum.
  - After vibration, tap the outside of mold lightly 10 to 15 times with the mallet to close holes left by vibrating and to release trapped air bubbles.

After consolidation, strike off the top surface to the required tolerance. A wood float may be used.

Perform all finishing with the minimum manipulation necessary to produce a flat, even surface, which is level with the edge of the mold and that has no depressions or projections larger than 1/8 in. (3.3 mm).

Curing Specimens

The following tables describe the steps used in curing specimens at the job site and the laboratory.

- Jobsite

Immediately after finishing, take precautions to prevent evaporation and loss of water from the specimens.

Curing Specimens at the Job Site	
Step	**Action**
1	Cover the specimens with a nonabsorbent, nonreactive plate or sheet of impervious plastic. ♦ Wet burlap or cotton mats may be used over the plate or plastic sheet to help retard evaporation, but the burlap or cotton mats must not touch the surface of the concrete. ♦ Keep the covering thoroughly saturated until removal of the cylinders from the molds. *NOTE*: Storage conditions during the first 48 hr. have an important influence on the strength developed in concrete.
2	Store test specimens under conditions that prevent loss of moisture and where the temperature range is 60 to 80°F (16 to 27°C).
3	Within 24 to 48 hr. after making the specimen, transport the specimen in the mold to the location of the jobsite curing tank.
4	Remove the mold being careful not to damage the test specimen.
5	Place the specimen in the curing tank and keep immersed in saturated limewater maintained at a temperature of 60 to 80°F (16 to 27°C). Do not expose the specimens to a stream of flowing water.
6	Cure the test specimens at jobsite for at least 3/4 of the curing period.
7	When shipping to the laboratory, carefully wrap the specimens in wet paper and secure in wet burlap or seal in a plastic bag.

- Test specimens representing tests for removal of forms and/or false work must be cured using the same methods as the concrete represented.

NOTE: Between the time the specimen is removed from curing until testing is completed, do not let the surfaces dry. Relatively small amounts of drying of the surface of flexural strength specimens will induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

- Laboratory

To prevent evaporation of water from the unhardened concrete, cover the specimens immediately after finishing with a nonabsorptive, nonreactive plate or a sheet of tough, durable, impervious plastic.

- Wet burlap may be used for covering, but care must be exercised to keep the burlap wet until the specimens are removed from the molds.
- Placing a sheet of plastic over the burlap will facilitate keeping it wet.

Remove the specimens from the molds not less than 20 hr. nor more than 48 hr. after casting.

Unless otherwise specified, moist cure all specimens at 73 ±3°F (23 ±2°C) from the time of molding until the moment of testing. During the initial 48 hr. of curing, store in a vibration free environment. As applied to the treatment of de-molded specimens, moist curing means that the test specimens must have free water maintained on the entire surface area at all times. This condition may be met by immersion in saturated limewater or by storage in a moist room or cabinet meeting the requirements specified in the 'Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cement and Concrete.' Do not expose specimens to dripping or running water.

Immerse specimens cured in a moist room in saturated limewater a minimum period of 20 hr. immediately before testing. At the end of the curing period, between the times the specimen is removed from curing until testing is completed, do not let the surfaces dry.

NOTE: Relatively small amounts of drying of the surface of flexural strength specimens will induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

Section 4

Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cement and Concrete

Definitions

This test method references the following terms and definitions:

- Moist cabinet. A moist cabinet is a compartment storage facility of moderate dimensions with controlled temperature and relative humidity.
- Moist room. A moist room is a "walk-in" storage facility with controlled temperature and relative humidity. It is commonly called a fog room when the prescribed relative humidity is achieved by the atomization of water.

Requirements

Below are the requirements for moist rooms, moist cabinets and water storage tanks.

General

The atmosphere in a moist cabinet or room must have a temperature of 73.5 ±3.5°F (23 ±2.0°C) and a relative humidity of not less than 95%. The moisture in the atmosphere must be saturated to the degree needed to ensure that the exposed surfaces of all specimens in storage will both look moist and feel moist at all times. Equip all storage units with recording thermometers. The use of humidity recording devices is optional. Shelves on which fresh specimens sit must be level.

The air in a moist storage unit must be nearly saturated with moisture to provide specified storage conditions. In many cases, saturation of specimens is below optimum during periods when placing in or removing from storage. Do not make measurements of relative humidity at such obviously inopportune times.

Audit the recordings from the recording thermometer in order to ascertain the adequacy of the mechanisms used to control the moist room air temperature.

Moist Cabinets

A moist cabinet must be constructed of durable materials and the doors must be tight-fitting.

Maintain the specified relative humidity shall be maintained by the use of 1 or more fog sprays, water sprays, or curtains of water on the inner walls that are so directed that the discharge will collect in a pool at or near the bottom of the moist storage section.

Provide automatic control of air temperature where a cabinet is located in a nonconditioned workroom and in any other instance where difficulty in maintaining temperatures within the specified range is encountered.

Moist Rooms

Moist room walls must be constructed of durable materials, with tight fitting doors and windows.

Control the temperature thermostatically, with provisions for heating, cooling, or both, as needed.

The sensing element must be located in the moist room.

Maintain the specified relative humidity in any convenient and suitable manner. However, use air-water sprays with abrasion-resistant orifices in all instances where other devices obtain unsatisfactory results.

Moist Rooms Used in Cement Testing

Durable shelving, properly shielded to prevent droplets of water from falling on the surfaces of freshly molded specimens, must be available within each room.

Moist Rooms Used in Concrete Testing

Atmospheric conditions within each room must be such that test specimens in storage will have free water maintained on their entire surface area at all times. Do not expose specimens to dripping or running water.

Water Storage Tanks

- Jobsite
  - Tanks must be constructed of noncorroding materials, with controlled water temperatures between 60 and 80°F (16 and 27°C) if a tank is in a room without temperatures controlled within that range, and in any other instance where difficulty in maintaining temperatures within the specified range is encountered.
  - Equip each tank with a recording, or minimum/maximum, thermometer with its sensing element in the storage water.
  - The water in a storage tank must be clean, and saturated with lime. Do not use continuous running or demineralized water in storage tanks as it may affect test results due to excessive leaching.
- Laboratory
  - Supply tanks constructed of noncorroding materials.
  - Make provision for automatic control of water temperature to 73.5 ±3.5°F (23 ±2.0°C) if a tank is located in a room without temperatures controlled within that

range and in any other instance where difficulty in maintaining temperature within the specified range is encountered.

- Equip each tank located in a space not controlled to 73.5 ±3.5°F (23 ±2.0°C) with a recording thermometer with its sensing element in the storage water.
- The water in a storage tank must be clean and saturated with lime. Do not use continuous running or demineralized water as it may affect test results due to excessive leaching.

Section 5

Archived Versions

Archived versions of "Tex-447-A, Making and Curing Concrete Test Specimens" are available through the following links:

- Click on 447-0899 for the test procedure effective August 1999 through May 2000.
- Click on 447-0600 for the test procedure effective June 2000 through November 2004.