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

Overview


This 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 provision for 102 x 203 mm (4 x 8 in.) cylinders and provisions for curing at remote sites, this test method conforms to ASTM C 31, AASHTO T 23, ASTM C 192 and AASHTO T 126.

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 7000 vibrations per minute or greater, with the outside diameter or side dimension of the vibrating elements at least 19 mm (3/4 in.), and not greater than 1/4 the diameter of the specimen.
  • The combined length of the shaft and vibrating element must exceed the maximum depth of the section being vibrated by a minimum of 76 mm (3 in.)
  • A vibrating-reed tachometer should be used to check the frequency of vibration.

♦ tamping rods
  • one 16 mm (5/8 in.) in diameter and approximately 610 mm (24 in.) long
  • the other 9.5 mm (3/8 in.) in diameter and approximately 305 mm (12 in.) 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 0.57 ± 0.23 kg (1.25 ± 0.50 lb.)

♦ burlap or cotton mats

(continued...)
Apparatus (continued)

- 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
  - water tight, circular cylinders made of steel, cast iron, or other non-absorbent material, non-reactive with concrete containing Portland or other hydraulic cements,
  - that stand with cylindrical axes vertical and the top open, with a nominal inside height equal to twice the nominal inside diameter.
  - The average diameter of a mold should not differ from the nominal diameter by more than 1%. No diameter of a mold should differ from any other diameter of the same mold by more than 2%.
  - The average height should 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 degrees (approximately equivalent to 3 mm in 300 mm [1/8 in. in 12 in.]).
  - Paper, cardboard, or sheet metal molds are not permitted.
  - Single-use molds and caps are made of molded polyethylene or plastic designed to be used a single time.
  - A representative sample of each shipment of molds must be measured for roundness on the open end of the mold; two diameters measured at right angles to each other shall be used to determine compliance to the tolerances stated above.
  - Molds that do not meet those dimensions must not be used.
  - Molds which are not sufficiently strong and tough to permit use under normal construction conditions without tearing, crushing or otherwise deforming when filled with fresh concrete should be rejected.
  - Use a snap on locking plastic cap with the mold to prevent water loss and add rigidity.
  - Caps must not be stored inside cylinder molds prior to use.
  - Reusable molds are constructed from a rigid material and designed to be used more than a single time.
  - Molds must be provided with a closure or base on the lower end at right angles to the axis of the cylinder.
  - A suitable sealant, such as heavy grease or molding clay, should be used where necessary to prevent leakage through the joints of the assembled mold.

(continued...)

Apparatus (continued)
- A cover plate must be provided for each mold. A 125 x 125 mm (5 x 5 in.) plate for 100 mm (4 in.) molds and a 200 x 200 mm (8 x 8 in.) plate for 150 mm (6 in.) molds will be adequate.

NOTE: Satisfactory reusable molds can be made from lengths of tubing or pipe that are 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. Required dimensional tolerance must be maintained after slitting, clamping and attaching the base plate.
- cover plates or caps, made of steel, cast iron, or other non-absorbent material, non-reactive with concrete containing Portland or other hydraulic cements.

Test Specimens

Below are the requirements for standard test specimens:
- The standard specimens may be 150 x 300 mm (6 x 12 in.) or 100 x 200 mm (4 x 8 in.) cylinders. The diameter of the specimen must be at least three times the nominal maximum size of coarse aggregate in the concrete. Do not use molds of 102 mm (4 in.) when more than 5% of the design coarse aggregate content is larger than 37.5 mm (1½ in.).
- The specimens are subject to the same tolerances as the molds.

Sample

The sample of concrete from which test specimens are made must be representative of the entire batch, and obtained according to Test Method “Tex-407-A, Sampling Freshly Mixed Concrete.”

Molding Test Specimens

Below are the requirements for molding test specimens.
- Mold specimens promptly on a level, rigid, horizontal surface, free from vibration and other disturbances, as near as practical to where they are to be stored.
- Immediately after being struck off, cover the specimens and move to the place where they will remain undisturbed for the initial curing period.
- If specimens made in single use molds are moved, lift and support the specimens from the bottom of the molds with a large trowel or other flat device.
Consolidation

Described below are the methods of consolidation.

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

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

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

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

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

♦ Rodding:
  • Form test cylinder by placing concrete in the mold in three 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.
  • All particles of aggregate larger than 50 mm (2 in.) in size should be removed. Rod each layer 25 times with the rounded end of the tamping rod, distributing the strokes uniformly over the cross section of the mold.
  • 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 air bubbles that may have been trapped.
  • 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 two layers.
  • Use three insertions of the vibrator at different points for each layer.
  • Do not allow vibrator to rest on or touch the bottom or sides of the mold.
  • Carefully withdraw vibrator in such a manner that air pockets left in the specimen are kept to a minimum.
  • Allow vibrator to penetrate the top layer and into the bottom layer approximately 25 mm (1 in.).

(continued...)
Consolidation (continued)

- After the layer is vibrated, tap the outside of the mold lightly 10 to 15 times with the mallet to close any holes that remain and to release air bubbles that may have been trapped.
- 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 3.2 mm (1/8 in.).

Curing Specimens

Described below are the requirements for curing specimens at the job site and in the laboratory:
- **Job Site**
  - Storage conditions during the first 24 hours have an important influence on the strength developed in concrete.
  - During the first 24 hours, all test specimens shall be stored under conditions that prevent loss of moisture and where the temperature range is 16 to 27 °C (60 to 80 °F).
  - Immediately after forming the cylinders, cover them with cover plates or caps, then with several thicknesses of wet burlap or wet cotton mats.
  - Keep the covering thoroughly saturated until the cylinders are removed from the molds.
  - Approximately 24 hours after the cylinders are made, transport them in the molds to the job-site curing tank.
  - Remove the mold, being careful not to damage the cylinder.
  - Place the cylinder in the curing tank and keep immersed in saturated lime water maintained at a temperature 16 to 27 °C (60 to 80 °F).
  - Do not expose the cylinders to a stream of flowing water.
  - Cure test specimens representing tests for removal of forms and/or false-work using the same methods as the concrete represented at the job site for at least 4 days after casting, prior to transporting to the laboratory for testing.
  - Wrap the cylinders carefully in wet paper, secure in wet burlap or seal in a plastic bag, or otherwise suitably prepare them for shipment to the laboratory.

(continued...
Curing Specimens (continued)

♦ Laboratory
  • Two to four hours after forming the test specimen cover the mold with the cover plate and allow sitting undisturbed for at least 24 hours.
  • Then remove the mold and place the cylinder in the moist room to cure under conditions of controlled temperature of 23 ± 1.7 °C (73.4 ± 3 °F) and a relative humidity of not less than 95% for the specified time.

Part II, Flexure Strength Specimens (Beams)

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

Apparatus

The following apparatus is required:

♦ beam molds
  • Made of steel, cast iron, or other non-absorbent material, non-reactive with concrete containing Portland or other hydraulic cements.
  • Molds must hold their dimensions and shape under severe use. Molds must be watertight. A suitable sealant, such as heavy grease, modeling clay or micro-crystalline wax may be used where necessary to prevent leakage through the joints.
  • Molds shall be lightly coated with mineral oil or a suitable non-reactive release material before use.
  • Molds shall be rectangular in shape with 150 x 150 x 508 mm (6 x 6 x 20 in.) nominal dimensions. The inside surfaces of the molds shall be smooth and free from blemishes. The sides, bottom, and ends shall be at right angles to each other and shall be straight, true, and free of warpage. Maximum variation from the nominal cross-section shall not exceed 3.2 mm (1/8 in.).
  • Molds must not be more than 1.6 mm (1/16 in.) shorter than the nominal length, but may exceed it by more than that amount.

♦ tamping rod, a straight steel rod 16 mm (5/8 in.) in diameter and approximately 610 mm (24 in.) in length with one end rounded to a 16 mm (5/8 in.) 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 shall be rectangular beams of concrete cast and hardened with the long axis horizontal.

Unless another size is required by the project specifications, test beams shall be 150 x 150 x 508 mm (6 x 6 x 20 in.) subject to the same tolerances as for molds.

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

Sampling

Below are the sampling requirements for concrete used in making and curing concrete test specimens:

Sample freshly-mixed concrete according to Test Method “Tex-407-A, Sampling Freshly-Mixed Concrete.” All aggregate particles larger than 51 mm (2 in.) should be removed.

NOTE: ASTM requires that coarse aggregate larger than 37.5 mm (1½ in.) be removed by wet-sieving. TxDOT allows for the larger aggregate to be removed by hand.

Molding Test Specimens

The following table describes the procedure for molding test specimens:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
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| 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 hours.  
♦ If it is not practicable to mold the specimens where they are to be stored, move them to the place of storage immediately after being struck 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, 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 non-representative 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 75 mm (3 in.). Rod or vibrate concrete with a slump of 25 to 75 mm (1 to 3 in.).

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

♦ Rodding:
   • Place concrete in mold in two layers.
   • Rod each layer with the rounded end of rod.
   • The number of roddings per layer required for beams is one for each 1300 mm² (2 in.²).
   • Use 60 strokes for a 150 x 150 x 508 mm (6 x 6 x 20 in.) 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 12 mm (0.5 in.) 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 air bubbles that may have been trapped.
   • 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 150 mm (6 in.) 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 vibrator so that air pockets left in the specimen are kept 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 air bubbles that may have been trapped.

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 that is level with the edge of the mold and that has no depressions or projections larger than 3.2 mm (1/8 in.).
Curing Specimens

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

♦ Job Site

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

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<th>Curing Specimens at the Job Site</th>
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♦ Test specimens representing tests for removal of forms and/or false work shall be cured using the same methods as the concrete represented.

NOTE: Between the time the specimen is removed from curing until testing is completed, drying the surfaces shall be prevented. 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 non-absorptive, non-reactive 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.

(continued...)
Curing Specimens (continued)

Remove the specimens from the molds not less than 20 nor more than 48 hours after casting. Unless otherwise specified, moist cure all specimens at 23 ± 1.7 °C (73.4 ± 3 °F) from the time of molding until the moment of test. Store in a vibration free environment during the initial 48 h of curing. As applied to the treatment of de-molded specimens, moist curing means that the test specimens shall have free water maintained on the entire surface area at all times. This condition may be met by immersion in saturated lime water or by storage in a moist room or cabinet meeting the requirements specified in the Appendix. Do not expose Specimens to dripping or running water.

Specimens cured in a moist room shall be immersed in saturated-lime water a minimum period of 20 hours immediately prior to testing. At the end of the curing period, between the time the specimen is removed from curing until testing is completed, drying the surfaces shall be prevented.

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.

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

Definitions

The following terms and definitions are referenced in this test method:
- 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. 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 shall have a temperature of 23 ± 1.7 °C (73.4 ± 3 °F) and a relative humidity of not less than 95%. The moisture in the atmosphere shall 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. All storage units shall be equipped with recording thermometers. The use of humidity recording devices is optional. Shelves on which fresh specimens are placed shall be level.
♦ The air in a moist storage unit must be nearly saturated with moisture to provide specified storage conditions. In many cases, saturation is below optimum during periods when specimens are being placed in or removed from storage. Measurements of relative humidity should not be made at such obviously inopportune times.

♦ The recordings from the recording thermometer shall be audited in order to ascertain the adequacy of the mechanisms used to control the moist room air temperature.

**Moist Cabinets**

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

♦ The specified relative humidity shall be maintained by the use of one 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.

♦ Provision for automatic control of air temperature shall be made where a cabinet is located in a non-conditioned workroom and in any other instance where difficulty in maintaining temperatures within the specified range is encountered.

**Moist Rooms**

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

♦ The temperature should be thermostatically controlled, with provisions for heating, cooling, or both, as needed.

♦ The sensing element must be located in the moist room.

♦ The specified relative humidity may be maintained in any convenient and suitable manner. However, air-water sprays with abrasion-resistant orifices should be employed in all instances where satisfactory results have not been obtained with other devices.

**Moist Rooms Used in Cement Testing**

♦ Durable shelving that is properly shielded to prevent droplets of water from falling on the surfaces of freshly molded specimens shall be available within each room.

**Moist Rooms Used in Concrete Testing**

♦ Atmospheric conditions within each room shall be such that test specimens in storage shall have free water maintained on their entire surface area at all times. Specimens shall not be exposed to dripping or running water.

**Water Storage Tanks**

♦ Job Site

   • Tanks must be constructed of non-corroding materials, with controlled water temperatures between 16 and 27 °C (60 and 80 °F) 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 shall be clean, and saturated with lime. Continuous running or demineralized water may affect test results due to excessive leaching and should not be used in storage tanks.

♦ Laboratory

• Tanks must be constructed of non-corroding materials.

• Make provision for automatic control of water temperature to 23 ± 1.7 °C (73.4 ± 3 °F) 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.

• Each tank located in a space not controlled to 23 ± 1.7 °C (73.4 ± 3 °F) must be equipped 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. Continuous running or demineralized water may affect test results due to excessive leaching and should not be used.