Method of Test for

MAKING, FIELD CURING AND TRANSPORTING CONCRETE TEST SPECIMENS

DOTD Designation: TR 226

I. Scope

A. This procedure provides standardized requirements for making, curing, protecting, and transporting concrete compression and flexural test specimens under field conditions.

II. Reference Documents

A. DOTD S 301 – Sampling Fresh Concrete.
B. AASHTO M 205 – Molds for Forming Concrete Test Cylinders Vertically.
C. AASHTO T 23 – Making and Curing Concrete Test Specimens in the Field.
D. ASTM C31 –Making and Curing Concrete Test Specimens in the Field.

III. Apparatus

A. Cylinder Molds – Right circular cylinders having a nominal inside diameter of 6 inches and a length of 12 inches or right cylinder molds having a nominal inside diameter of 4 inches and a length of 8 inches for casting concrete compression test specimens vertically.
   1. Single Use Molds – Approved plastic molds, to be used only once, with a rigid lipped opening, light gray or light in color in order that permanent black ink markings on containers can be easily read. All molds shall conform to AASHTO M 205. Cardboard cylinder molds shall not be used for standard-cured specimens.
   2. Reusable Molds – Approved metal molds, intended for use more than once, with a metal base plate. The assembled mold shall be such that the base plate is at right angles to the longitudinal axis of the cylinder and shall conform to AASHTO M 205.

B. Beam Molds – Rectangular metal molds having a nominal inside cross-section equal to 6 inches by 6 inches. The length shall be at least 20 inches. Beam molds shall conform to AASHTO T 23.
C. Sampling Receptacle – Suitable heavy gauge metal pan, wheelbarrow, or flat, clean nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with shovel or trowel.
D. Tamping Rod for 6 in. by 12 in. Molds – The tamping rod for 6 inch diameter cylinders shall be a round, smooth, straight, steel rod, approximately 5/8 inches in diameter and 24 inches in length, having each end rounded to a hemispherical tip of the same diameter as the rod.
E. Tamping Rod for 4 in. by 8 in. Molds – The tamping rod for 4 inch diameter cylinders shall be a round, smooth, straight, steel rod, approximately 3/8 inches in diameter and 10 inches in length, having each end rounded to a hemispherical tip of the same diameter of the rod.
F. Mallet – With a rubber head having a mass of 1.25 ± 0.50 pounds.
G. Work Base – Stable platform or foundation rigid enough to accommodate a minimum of three (3) molds, (i.e., concrete, plywood, etc.).
H. Thermometer – Having a range of 0°F to 200°F, graduated in 2°F increments.
I. Small Tools – Pail or bucket, trowel, scoop, timer or watch, water, brush or cloth.
J. Straightedge – Approximately 1-3/8 inches wide by 3/16 inches thick by 12 inches long with a 1/4 inch bevel on one side.

K. Curing Supplies – Approved polyethylene bags and rubber bands or an approved plastic cap, and burlap.
L. Sealant – Any waterproofing sealant for use with metal molds.
M. Transport Box – Box with suitable cushioning material to prevent jarring damage during transport and capable of holding the cylinders in a vertical position (Figures 1-A and 1-B).
N. Form Release Agent – Mineral oil or an approved form release agent for use with metal molds.
O. Pen – Waterproof black ink marker.
P. Worksheet – Structural Concrete Tests, DOTD Form No. 03-22-0740 (Figure 2).

IV. Sampling

Obtain sample in accordance with DOTD S 301.

V. Molding Specimens

A. Specimen Preparation
1. Single Use Molds – Before concrete is placed into the mold, identify each specimen by writing on the side of the cylinder mold with the black ink marker the sample number, lot number, project number, and date of pour.
2. Reusable Metal Molds – Assemble mold to base plate and lightly coat the inner surface with the form release agent. The assembled mold shall be watertight. Use a sealant where necessary to prevent leakage through the joints.
3. For specimens that are to be used for putting structures into service, form removal, or acceptance of precast concrete, the location of molding shall be as near as possible to the portion of the structure or structural member represented by the specimens.

B. Molding (6 inch by 12 inch Cylinders) Compressive Test Specimens
1. Promptly place the mold(s) on a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored during the first 20 hours. If the ground is not level, place the molds on a level, stable work base.
2. For a 6 inch by 12 inch specimen, use a scoop or trowel to place the concrete into the 6 inch diameter cylinder mold in an even layer that will yield approximately 1/3 the volume of the mold.
3. When placing the concrete into the mold move the scoop or trowel around the perimeter of the mold opening to ensure an even distribution of the concrete and to minimize segregation.
4. Rod the layer 25 times with the tamping rod, distributing the strokes uniformly over the cross section of the mold. Rod the layer throughout its depth without damage to the bottom of the mold.
5. Tap the sides of the mold to eliminate voids left by rodding. Tapping is to be done around the circumference of the mold at the mid-point of each layer.
6. For single use molds, lightly tap the sides of the mold around the circumference 10 to 15 times using the mallet or the palm of the hand.
7. For reusable molds, tap the sides 10 to 15 times using the mallet.

Note 1: *Do not use the tamping rod or any other object other than the mallet or palm of the hand to tap the sides of the mold.*

8. Repeat steps 2-7 for two (2) more layers with the following exception.

a. Each layer shall be rodded 25 times, penetrating each underlying layer approximately 1/2 inch.
b. When placing the final layer, slightly overfill the mold no greater than 1/2 inch.

9. After consolidation of the final layer, strike off the surface of the concrete and finish with the straightedge. Perform all finishing with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the mold and that has no depression or projections larger than 1/8 inch.

Note 2: *Molding of test specimens shall be completed within 15 minutes from the time the sample was taken.*

C. Molding (4 inch by 8 inch Cylinders) Compressive Test Specimens

1. Place the mold(s) on a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored during the first 20 hours. If the ground is not level, place the molds on a level, stable work base.
2. For a 4 inch by 8 inch specimen, use a scoop or trowel to place the concrete into the 4 inch diameter cylinder mold in an even layer that will yield approximately ½ the volume of the mold.
3. When placing the concrete into the mold move the scoop or trowel around the perimeter of the mold opening to ensure an even distribution of the concrete and to minimize segregation.
4. Rod the layer 25 times with the tamping rod, distributing the strokes uniformly over the cross section of the mold. Rod the layer throughout its depth without damage to the bottom of the mold.
5. Tap the sides of the mold to eliminate voids left by rodding. Tapping is to be done around the circumference of the mold at the mid-point of each layer.
6. For single use molds, lightly tap the sides of the mold around the circumference 10 to 15 times using the mallet or the palm of the hand.
7. For reusable molds, tap the sides 10 to 15 times using the mallet.

Note 3: *Do not use the tamping rod or any other object other than the mallet or palm of the hand to tap the sides of the mold.*

8. Repeat steps 2-7 for one (1) more layer with the following exception.
   a. Each layer shall be rodded 25 times, penetrating each underlying layer approximately 1/2 inch.
   b. When placing the final layer, slightly overfill the mold no greater than 1/2 inch.
9. After consolidation of the final layer, strike off the surface of the concrete and finish with the straightedge. Perform all finishing with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the mold and that has no depression or projections larger than 1/8 inch.

Note 4: *Molding of test specimens shall be completed within 15 minutes from the time the sample was taken.*

D. Molding Flexural Test Specimens

1. Assemble the metal mold and lightly coat the inner surface with the form release agent. Use the sealant where necessary to prevent leakage through the joints. The assembled mold shall be watertight.
2. Place the assembled mold on a level, rigid, horizontal surface, free from vibration and other disturbances at the location where it is to be stored during the first 20 hours. If

the ground is not level, place the assembled mold on a level, stable work base.

3. Using a scoop or trowel, place the concrete in the beam mold in one even layer approximately 3 inches in depth.
4. Rod the layer with the 5/8 inch tamping rod once for each 2 square inches (2 in^2) of top surface area of the specimen or 60 strokes for a 6 in. x 6 in. x 20 in. mold. Distribute the strokes uniformly over the cross section of the mold. Rod the layer throughout its depth without damage to the bottom of the mold.
5. Using the mallet, lightly tap the sides of the mold 10 to 15 times to eliminate voids left by rodding.
6. After tapping, slightly round (spade) each layer of the concrete along the sides and ends of the beam mold with the trowel.
7. Repeat steps 3–6 for one more layer with the following exception:
   a. When placing the second layer of concrete, slightly overfill the mold no greater than 1/2 in.
   b. When molding, penetrate the underlying layer approximately 1/2 in. with the 5/8 inch tamping rod.
8. After the second layer has been rodded and the sides of the mold have been tapped, use a sawing motion with the straightedge to strike off the top surface of the concrete even with the top of the mold. Then use the straightedge to produce an even surface with no depressions or projections greater than 1/8 in.

Note 5: *Molding of test specimens shall be completed within 15 minutes from the time the sample was taken.*

E. Protection of Specimens
   1. To protect the specimens and prevent moisture loss, immediately cover the specimens after completion of molding with a polyethylene bag or plastic cap over the exposed surface of each specimen. Do not allow the polyethylene bag or plastic cap to come in contact with the plastic concrete. Use a rubber band to secure the bag on the mold.
   2. In hot weather, shield the specimens from direct sunlight.
   3. In cold weather, maintain the proper curing temperature range.

F. Specimen Identification
   1. Record all sample identification information on worksheet, including the time specimens were made.
   2. Single use molds were identified before the concrete was placed in them.
   3. For reusable molds, after initial set and before removal from the mold, remove the polyethylene bag or plastic cap and mark the top of the cylinder using the black ink marker with the sample number, lot number, project number, and date of pour. To prevent moister loss, recover the specimen with the bag or cap after labeling.
   4. For beam molds, after the concrete is sufficiently set, remove the polyethylene bag(s) and identify each specimen by marking the following information on the top surface of the beam with a black ink marker. To prevent moisture loss, recover the specimen with the bag after labeling.
      a. Sample Number
      b. Lot Number
      c. Project Number
      d. Date of Pour

VI. Procedure for Field Curing Specimens

A. Cast-in-Place Concrete

1. Specimens for Acceptance Compression Tests
    a. Do not disturb or move the molded specimens for the first 20 hours of curing.

Note 6: *If needed, specimens shall not be transported until at least 8 hours after final set.*

    b. Allow the specimens to cure in the molds as near as possible to the portion of the structure they represent for 48 ± 4 hours in a temperature range of 60°F – 80°F. For mixtures with a specified strength of 6,000 psi or greater, the curing temperature shall be between 68°F – 78°F.
    c. In hot weather, shield the specimens from direct sunlight.
    d. In cold weather, maintain proper curing temperature range.
    e. To ensure controlled curing environment, specimens may be placed in tightly constructed wooden boxes, damp sand pits, temporary buildings, or other suitable locations.
    f. Specimens may be stored in one of the above-mentioned manners for 48 ± 4 hours, after which time they must be transported, in the molds, to the lab in accordance with Section VII.
    g. Remove molds, store, and cure transported specimens with free water maintained on their surface at all times at a temperature of 73.5 ± 3.5 °F using water storage tanks or moist rooms until the specified age of testing.

2. Putting Structures into Service or Form Removal
    a. Do not move or disturb the molded specimens during the first 20 hours of curing.
    b. Allow specimens to cure in the molds as near as possible to the portion of the structure that they represent. Provide the specimens with the same temperature and moisture environment as the represented portion of the structure.
    c. On the same day as testing is to take place, transport the specimens in the mold to the laboratory in accordance with Part VII.

B. Precast Concrete

1. Specimen Acceptance and Form Removal
    a. Allow the specimens to cure while in the molds as near as possible to the portion of the structural member that they represent.
    b. Give the specimens the same protection from the elements and provide the same temperature and moisture environment as the represented structural member.
    c. For form removal purposes, take specimens directly from the curing environment, remove the molds and test. When molds are removed, transfer information from the molds to the specimens with a waterproof black ink marker.
    d. For acceptance purposes, when the forms are removed from the structural members, remove the molds from the specimens, transfer the information on the molds to the specimens with a waterproof black ink marker and allow the concrete specimens to cure in the same environment as the structural member prior to testing.
    e. Precast and prestressed concrete compressive strength and surface resistivity samples may be thermocouple controlled cured to match the temperature of the cast elements.

VII. Transporting Test Specimens

A. Cast-in-Place Concrete
   1. Specimens shall not be transported until at least 8 hours after final set.
   2. Transport test specimens while still in the mold and keep the specimens covered with the polyethylene bags or plastic caps.
   3. Do not damage specimens during handling or transporting.
   4. Place compression test specimens in a transport box.
   5. Protect flexural test specimens with suitable cushioning material.

B. Precast Concrete
   1. Do not damage specimens during handling or transporting.

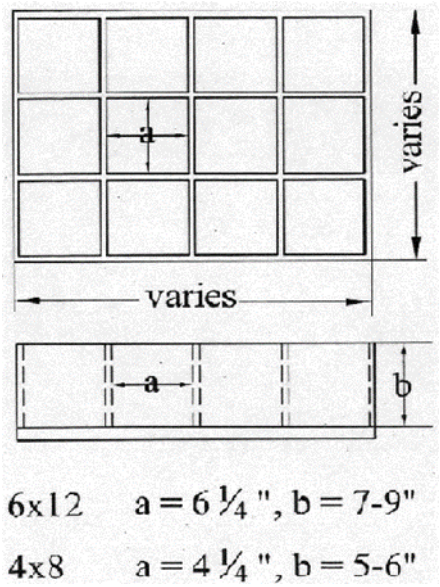
VIII. Report

A. Worksheet (Figure 2) shall be completed for each lot, pour or specimen. Enter on the worksheet all information required to identify the specimen and the structure it represents.

Note 7: *There is no test report generated with this procedure. For cast-in-place concrete, transporting of cylinders to the testing facility is from 20 hours to 2 days. Precast concrete varies with the curing method and the plant's operations.*

IX. Normal Test Reporting Time

A. Maximum time for making cylinders is 15 minutes.
B. Minimum time for field curing cylinders is 20 hours.
C. Maximum time for field curing cylinders is 48 ± 4 hours or 8 hours after final set, whichever is longer.



(Figure 1-A)
Dimensions of a Typical Concrete Cylinder Transport Box

(Figure 1-B)
Photograph of a Typical Concrete Cylinder Transport

Note 8: *The bottom of each compartment may be cushioned with ½ inch closed cell polyethylene or similar material.*

Louisiana Department of Transportation and Development
STRUCTURAL CONCRETE TESTS
(DOTD TR 226 & TR 230)

DOTD 03-22-0740
Rev. 09/19

Project No.: _____ Material Code: _____ Lot No.: _____

Date Sampled: ____/____/____ Submitted By: _____ Quantity: _____

Purpose Code: _____ *Please choose from list below.*

1. *Qual. Cont.* 4. *Check* 7. *Design*
2. *Verification* 5. *Resample* 8. *Indep. Assur.*
3. *Acceptance* 6. *Source Appr.* 9. *Pre. Source Test*

Plant Code: _____

Mix Design No.: _____

Date Received (lab): ____/____/____

Admixture: AEA ____ Type A: WR-NS ____ Type B: SR ____ Type C: SA ____ Type D: WR-SR ____
Type E: WR-SA ____ Type F: HR-WR-NS ____ Type G: HR-WR-SR ____ Type S: Specific ____

Item No: _____

Cylinders Made By: _____ Acceptance Test By: _____

Batch Number _____ **Acceptance Tests**

Date Tested ____/____/____ Slump (TR 207), (in) _____ Air Content (TR 202), % _____

Sample No.	Laboratory No.	Condition Code	Break Code	Age Days	Diam. (in.)	Area (in²)	Max. Load (lb.)	Strength (PSI)	Not used in Avg.
									☐
									☐
									☐

Time Made: _____ Outlier Strength Limits: Lower _____ Upper _____ Batch Avg. _____

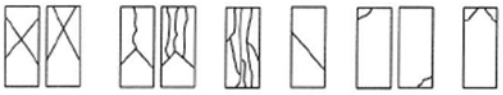
Batch Number _____ **Acceptance Tests**

Date Tested ____/____/____ Slump (TR 207), (in) _____ Air Content (TR 202), % _____

Sample No.	Laboratory No.	Condition Code	Break Code	Age Days	Diam. (in.)	Area (in²)	Max. Load (lb.)	Strength (PSI)	Not used in Avg.
									☐
									☐
									☐

Time Made: _____ Outlier Strength Limits: Lower _____ Upper _____ Batch Avg. _____

Break Codes:



Condition Codes:
1=Good
2=Improperly Made
3=Damaged
4=Frozen

Average Strength for Lot: _____
Tested By: _____
Checked By: _____
% Pay: _____

Remarks: _____

Approved By: _____

References: ASTM C173, C31, C1231, C39, C617, C143, C231, C172, C1064

(Figure 2)
Structural Concrete Worksheet

Louisiana Department of Transportation and Development
STRUCTURAL CONCRETE TESTS
(DOTD TR 226 & TR 230)

DOTD 03-22-0740
Rev. 02/19

Project No.: H.012345.6 Material Code: 0901M100450 Lot No.: 014
Date Sampled: 11 / 08 / 2018 Submitted By: 0722 Quantity: 4,000
Purpose Code: 3 *Please choose from list below.* Plant Code: C723
1. *Qual. Cont.* 4. *Check* 7. *Design* Mix Design No.: 001
2. *Verification* 5. *Resample* 8. *Indep. Assur.* Date Received (lab): 11 / 08 / 2018
3. *Acceptance* 6. *Source Appr.* 9. *Pre. Source Test*

Admixture: AEA Y Type A: WR-NS ___ Type B: SR ___ Type C: SA ___ Type D: WR-SR ___
Type E: WR-SA ___ Type F: HR-WR-NS ___ Type G: HR-WR-SR ___ Type S: Specific ___
Item No: 805
Cylinders Made By: DOTD INSPECTOR Acceptance Test By: DOTD INSPECTOR

Batch Number 02 — **Acceptance Tests**
Date Tested 12 / 06 / 2018 Slump (TR 207), (in) 3.25 Air Content (TR 202), % 4.0

Sample No.	Laboratory No.	Condition Code	Break Code	Age Days	Diam. (in.)	Area (in²)	Max. Load (lb.)	Strength (PSI)	Not used in Avg.
14-3A	00214888	1	1	28	6.00	28.27	110,020	3,890	☐
14-3B	00214888	1	1	28	6.00	28.27	115,110	4,070	☐
14-3C	00214888	1	2	28	6.00	28.27	107,050	3,790	☐

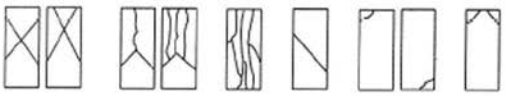
Time Made: 10:00 AM Outlier Strength Limits: Lower 3,330 Upper 4,510 Batch Avg. 3,920

Batch Number 06 — **Acceptance Tests**
Date Tested 12 / 06 / 2018 Slump (TR 207), (in) 3.50 Air Content (TR 202), % 4.0

Sample No.	Laboratory No.	Condition Code	Break Code	Age Days	Diam. (in.)	Area (in²)	Max. Load (lb.)	Strength (PSI)	Not used in Avg.
14-4A	00214888	1	2	28	6.00	28.27	108,030	3,820	☐
14-4B	00214888	1	2	28	6.00	28.27	109,510	3,870	☐
14-4C	00214888	1	1	28	6.00	28.27	113,550	4,020	☐

Time Made: 1:05 PM Outlier Strength Limits: Lower 3,320 Upper 4,490 Batch Avg. 3,900

Break Codes:



Condition Codes:
1=Good
2=Improperly Made
3=Damaged
4=Frozen

Avcrage Strength for Lot: 3,910 psi
Tested By: DOTD INSPECTOR
Checked By: DOTD INSPECTOR
% Pay: 100

Remarks:
(1) MINOR STRUCTURE CLASS M
(2) EARLY BREAKS FOR INFO PURPOSES ONLY

Approved By: DOTD INSPECTOR

References: ASTM C173, C31, C1231, C39, C617, C143, C231, C172, C1064

(Figure 2 Example)
Structural Concrete Worksheet Example