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. Louisiana Standard Specifications for Roads and Bridges
B. DOTD S 301 – Sampling Fresh Concrete
C. ASTM C1064 – Temperature of Freshly Mixed Concrete
D. DOTD TR 207 – Slump of Portland Cement Concrete
E. DOTD TR 202 Method A & B – Air Content of Freshly Mixed Concrete
F. DOTD TR 201 – Weight Per Cubic Foot, Yield, and Air Content (Gravimetric of Concrete)
G. AASHTO M 205 – Molds for Forming Concrete Test Cylinders Vertically
H. ASTM C470 - Specification for Molds for Forming Concrete Test Cylinders Vertically
I. AASHTO T 23 – Making and Curing Concrete Test Specimens in the Field
J. ASTM C31 – Making and Curing Concrete Test Specimens in the Field
K. ASTM C1758 – Fabricating Test Specimens with Self-Consolidating Concrete

III. Apparatus

A. 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.
B. Burlap or suitable material to cover plastic/fresh concrete from the elements.
C. Thermometer – Capable of being inserted into the fresh concrete and having a range of 30°F to 120°F, and capable of measuring to 1°F. Infrared surface thermometers are not permissible.
D. 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.
E. 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 or ASTM C470. Cardboard cylinder molds shall not be used for standard-cured specimens.
F. Reusable Molds – Approved metal molds, intended for use more than once, with a metal baseplate. The assembled mold shall be such that the base plate is at right angles to the longitudinal axis of the cylinders and shall conform to AASHTO M 205.
G. Tamping Rod for 6 inch by 12 inch 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.

H. Tamping Rod for 4 inch by 8 inch Molds – The tamping rod for 4 inch diameter cylinders shall be a round, smooth, straight, steel rod, approximately 3/8 inches in diameter and 12 inches in length, having each end rounded to a hemispherical tip of the same diameter of the rod.
I. Work Base – Stable platform or foundation rigid enough to accommodate a minimum of three (3) molds, (i.e., concrete, plywood, etc.).
J. Pouring Vessel for Self-Consolidating Concrete (SCC) – A watertight container having a large enough volume such that concrete is not spilled during placement of SCC in the specimen mold. (Example: Large pitcher or bucket with a lip)
K. Small Tools – Pail or bucket, leveling device, handheld float or trowel, 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) scoop, timer or watch, water, brush or cloth.
L. Mallet – With a rubber head having a mass of 1.25 ± 0.50 pounds.
M. Curing Supplies – Approved polyethylene bags and rubber bands or an approved plastic cap.
N. 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.
O. Vibrator – The vibrator frequency shall be at least 150 Hz (9,000 vibrations per minute). The diameter of a round vibrator shall be no more than one-fourth the diameter of the cylinder mold or one-fourth the width of the beam mold. The combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 3 inches.
P. Sealant – Any waterproofing sealant for use with metal beam molds.
Q. Form Release Agent – Mineral oil or an approved form release agent for use with metal beam molds.
R. Curing Chamber –The chamber shall provide an environment that prevents loss of moisture, maintain temperature within a range of 60-80 degrees Fahrenheit, and be equipped with a continuously recording thermometer accurate to +/- 2 degrees Fahrenheit. For mixtures with a specified strength of 6,000 psi or greater, the curing temperature shall be between 68-78 degrees Fahrenheit. Provide data from the thermometer as directed. Locate the chamber so that the cylinders are not subject to vibration. The chamber shall be of sufficient size to store the required number of cylinders in a manner satisfactory to the engineer. Provide multiple chambers as necessary.
S. Transportation Box – Box capable of holding the cylinders in a vertical position (Figures 1-A and 1-B) and may have suitable cushioning material to prevent jarring damage during transport.
T. Pen – Waterproof black ink marker.
U. Worksheet – Structural Concrete Tests, DOTD Form No. 03-22-0740 (Figure 2), or DOTD Approved Applications and Software.

IV. Sampling

A. Obtain sample in accordance with DOTD S 301.

V. Specimen Preparation

A. 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 batch number, lot number, project number, and date of pour. Do not write on the plastic caps or bags.

B. 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.

VI. Molding Specimens

Note 1: *For concrete with a slump less than 1 inch, consolidation of specimens by vibration is required. For concrete with a slump greater than or equal to1 inch, consolidation of specimens by rodding or vibration is allowed.*

Note 2: *Lightly tap the sides of the mold 10 to 15 times around the circumference of the mold at the mid-point of each layer to eliminate voids left by rodding. 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. For reusable molds, use the mallet.*

A. <u>Molding (6 inch by 12 inch Cylinders) Compressive Test Specimens by Rodding Method</u>

1. Promptly place the mold(s) on a stable work base that is a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored.
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. [Note 2]
6. Repeat steps 2-5 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.
7. After consolidation of the final layer, strike off the surface of the concrete with the tamping rod where the consistency of the concrete permits, or with a handheld float or trowel, and finish 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.

B. <u>Molding (6 inch by 12 inch Cylinders) Compressive Test Specimens by Vibration Method</u>

1. 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 1/2 the volume of the mold.

2. 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.
3. Distribute the insertion of the vibrator uniformly within the first layer of concrete two (2) times.
4. In compacting the specimen, insert the vibrator slowly and do not allow it to rest on the bottom or sides of the mold. Slowly withdraw the vibrator so that no large air pockets are left in the specimen.
5. Generally, no more than five (5) seconds of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 3 inches. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 seconds per insertion.
6. After vibration of the first layer of concrete, tap the sides of the mold. Note 2
7. For the final layer of concrete, allow the vibrator to penetrate through the layer being vibrated, and into the layer below, about 1 inch. Avoid overfilling by more than 1⁄4 inch.
8. After the final layer is vibrated two (2) times, tap the sides of the mold. Note 2
9. After consolidation of the final layer, strike off the surface of the concrete with the tamping rod where the consistency of the concrete permits, or with a handheld float or trowel, and finish 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.

C. Molding (4 inch by 8 inch Cylinders) Compressive Test Specimens by Rodding Method
1. Promptly place the mold(s) on a stable work base that is a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored.
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. Note 2
6. Repeat steps 2-5 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.
7. After consolidation of the final layer, strike off the surface of the concrete with the tamping rod where the consistency of the concrete permits, or with a handheld float or trowel, and finish 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.

D. Molding (4 inch by 8 inch Cylinders) Compressive Test Specimens by Vibration Method

1. 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 1/2 the volume of the mold.
2. 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.
3. Distribute the insertion of the vibrator uniformly within the first layer of concrete one (1) time.
4. In compacting the specimen, insert the vibrator slowly and do not allow it to rest on the bottom or sides of the mold. Slowly withdraw the vibrator so that no large air pockets are left in the specimen.
5. Generally, no more than five (5) seconds of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 3 inches. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 seconds per insertion.
6. After vibration of the first layer of concrete, tap the sides of the mold. Note 2
7. For the final layer of concrete, allow the vibrator to penetrate through the layer being vibrated, and into the layer below, about 1 inch. Avoid overfilling by more than 1⁄4 inch.
8. After the final layer is vibrated one (1) time, tap the sides of the mold. Note 2
9. After consolidation of the final layer, strike off the surface of the concrete with the tamping rod where the consistency of the concrete permits, or with a handheld float or trowel, and finish 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.

E. Molding Compressive Test Specimens Using Self-Consolidating Concrete (SCC)

1. Promptly place the mold(s) on a stable work base that is a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored.
2. Fill the pouring vessel with a portion of SCC from the sample receptacle, either by passing the pouring vessel through the concrete or by scooping concrete into the pouring vessel.
3. Using the pouring vessel, fill the specimen mold with the SCC. To avoid segregation, do not pour the SCC from a height greater than five (5) inches above the top edge of the specimen mold.
4. While filling the specimen mold, ensure an even distribution of concrete, without rodding, tapping or vibrating the sides of the specimen mold.
5. Fill the specimen mold slightly above the top.

6. Strike off the top surface of the SCC and finish with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the specimen mold and that has no depression or projections larger than 1/8 inch.

F. Molding Flexural Test Specimens by Rodding Method
   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 stable work base that is a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored.
   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, spade each layer of the concrete along the sides and ends of the beam mold with the trowel or other suitable tool.
   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 rodding, 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.

G. Molding Flexural Test Specimens by Vibration Method
   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 stable work base that is a level, rigid, horizontal surface, free from vibration and other disturbances at the location where they are to be stored.
   3. Using a scoop or trowel, place the concrete in the beam mold in one even layer. Place the concrete so that it is uniformly distributed within the entire layer with minimal segregation. Place approximately ¼ inch additional concrete over the top of the mold to completely fill the mold after consolidation.
   4. Insert the vibrator at intervals not exceeding 6 inches along the center line of the long dimension of the specimen.
   5. Insert the vibrator slowly and do not allow it to rest on the bottom or sides of the mold, then slowly withdraw the vibrator so that no large air pockets are left in the specimen.

6. No more than 5 seconds of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 3 inches. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 seconds per insertion.
7. After the layer is vibrated, tap the sides of the mold lightly 10-15 times with the rubber mallet.
8. After consolidation of the concrete, use a handheld float or trowel to strike off the top surface to the required tolerance to produce a flat, even surface.

VII. Protection of Specimens

A. 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 fresh plastic concrete. Use a rubber band to secure the bag on the mold.
B. Promptly move specimens to the temperature controlled curing chamber after the molding operation is complete and prior to initial set of the concrete.
C. Do not disturb or move the molded specimens for the first 20 hours of curing.

VIII. Procedure for Field Curing Specimens

A. Cast-in-Place Concrete, Internally Cured Concrete, and Self-Consolidating Concrete
   1. For Acceptance Compression Tests, protect specimens in accordance with Section VII of this procedure.
   2. For Form Removal and Early Breaks, allow specimens to cure in the molds for a minimum of 20 hours as near as possible to, and with the same temperature and moisture environment as the concrete component they represent.

B. Precast Concrete

***Note 3**: Specimens for compressive strength and surface resistivity may be thermocouple controlled and cured to match the temperature of the precast element(s).*

   1. For Acceptance Compression Tests, cure specimens in the molds as near as possible to the portion of the structural member they represent. Give specimens the same protection from the elements and provide the same temperature and moisture environment as the represented structural member.
   2. For Form Removal and Early Breaks, take specimens directly from the curing environment, remove the specimens from the molds, and test.

C. Latex Modified Concrete

   For Acceptance Compression Tests, protect specimens in accordance with Section VII of this procedure. Keep LMC specimens above 50 ºF throughout curing period.

D. High Early Strength Concrete

   For Acceptance Compression Tests and verification of Maturity Curve, promptly move the specimens to a tightly constructed insulated container without artificial heating or cooling to emulate the strength gain of the in-place concrete until time of testing.

IX. Specimen Identification After Field Curing

A. Identify single use molds before the concrete is placed in the mold. Transfer identification information from the mold to the specimen with a waterproof black ink marker immediately upon removal of the specimen from the mold.

B. For reusable molds and beam molds, after initial set and before removal from the mold, remove the polyethylene bag or plastic cap and identify each specimen by marking the top of the concrete specimen using the black ink marker with the following information:
   1. Sample number
   2. Lot number
   3. Project number
   4. Date of pour

C. Re-cover the specimen with the bag or plastic cap after labeling to prevent moisture loss.

D. Record the time specimens were made as well as all sample identification information on Structural Concrete Tests, DOTD Form No. 03-22-0740 (Figure 2).

X. Transporting Test Specimens

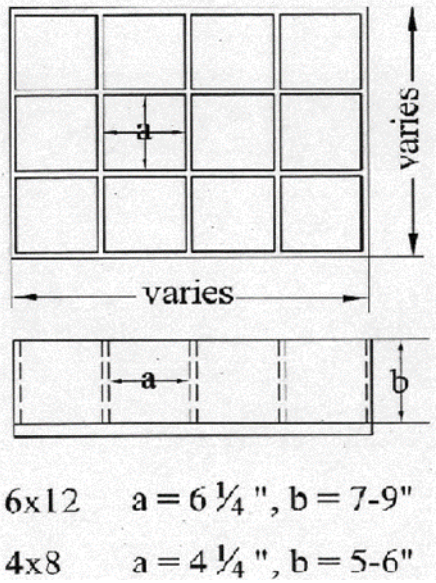
A. Cast-in-Place Concrete, High Early Strength Concrete, Internally Cured Concrete, Latex Modified Concrete, Precast Concrete, and Self-Consolidating Concrete
   1. Do not transport test specimens until at least 20 hours after molding.

***Note 4**: For High Early Strength Concrete & Precast Concrete this time may be reduced to account for the time needed to transport the specimens to the lab for testing at the appropriate age.*

   2. Transport specimens to the testing laboratory within 76 hours.
   3. Transport test specimens while still in the mold and keep the specimens covered with the polyethylene bags or plastic caps.
   4. Do not damage specimens during handling or transporting.
   5. Place compression test specimens in a transport box.
   6. Protect flexural test specimens with suitable cushioning material.
   7. If a specimen in a single-use mold is moved prior to initial set, support the bottom of the mold. If the top surface of a specimen is disturbed during movement to the place of initial storage, refinish the surface.

XI. Report

A. Structural Concrete Tests, DOTD Form No. 03-22-0740 (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.



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

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

Note 5: *The bottom of each compartment may be cushioned with ½ inch closed cell polyethylene foam or similar material.*

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

DOTD 03-22-0740
Rev. 05/23

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.: _____
Lab Address: _____
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 (in.²)	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 = Satisfactory	2 = Unsatisfactory	1 = Good
Type 1 Type 2 Type 3 Type 4	Type 5 Type 6	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 and TR 230)

DOTD 03-22-0740
Rev. 07/23

Project No.: H.000000.6 Material Code: 0000M00000 Lot No.: 014
Date Sampled: 11 / 01 / 2018 Submitted By: 0722 Quantity: 4,000
Purpose Code: 3 *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: 0723
Mix Design No.: 001
Lab Address: 5080 Florida Blvd.
Date Received (lab): 11 / 04 / 2018
Admixture: AEA X 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
Date Tested 11 / 29 / 2018
Acceptance Tests
Slump (TR 207), (in.) 3.25 Air Content (TR 202), % 4.0

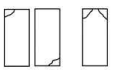
Sample No	Laboratory No.	Condition Code	Break Code	Age Days	Diam (in.)	Area (in.²)	Max Load (lb.)	Strength (PSI)	Not used in Avg.
14-2A	00214888	1	1	28	6.00	28.27	110,020	3,890	☐
14-2B	00214888	2	1	28	6.00	28.27	115,110	4,070	☐
14-2C	00214888	3	2	28	6.00	28.27	107,050	3,790	☐

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

Batch Number 06
Date Tested 11 / 29 / 2018
Acceptance Tests
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.
14-6A	00214999	4	2	28	6.00	28.27	108,030	3,820	☐
14-6B	00214999	1	2	28	6.00	28.27	109,510	3,870	☐
14-6C	00214999	2	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 = Satisfactory	2 = Unsatisfactory	1 = Good
 Type 1 Type 2 Type 3 Type 4	 Type 5 Type 6	2 = Improperly Made 3 = Damaged 4 = Frozen

Average Strength for Lot: 3,910 psi
Tested By: DOTD Inspector
Checked By: DOTD Inspector
% Pay: 100

Remarks:
(1) Minor Structure Class M

Approved By: DOTD Inspector

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

(Figure 3) Structural Concrete Worksheet - Example