

STUDY GUIDE



ACI Concrete Field Testing Technician, Grade I

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Mississippi Concrete Association Registered Student**

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Program Information: ACI Concrete Field Testing Technician, Grade I

Scope - This program requires a working knowledge of the following ASTM Standards:

1. ASTM C1064 - Temperature of Freshly Mixed Portland-Cement Concrete
2. ASTM C172 - Sampling Freshly Mixed Concrete
3. ASTM C143 - Slump of Hydraulic Cement Concrete
4. ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
5. ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method
6. ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method
7. ASTM C31 - Making and Curing Concrete Test Specimens in the Field

ABOUT THE WRITTEN AND PERFORMANCE TESTING

Certification Requirements

The American Concrete Institute (ACI) will grant certification only to those applicants who meet both of the following requirements:

1. A passing grade on the ACI written examination; and
2. Successful completion of the ACI performance examination.

The one-hour written examination is “closed book” and consists of 55 multiple choice questions. There are five (5) to ten (10) questions on each of the ASTM Standards. To pass the written examination, both of the following conditions must be met: (a) at least 60% correct for each of the required standards; and (b) a minimum score of 70% overall.

The performance examination is also “closed book” and requires demonstration of six of the required ASTM Standards plus a verbal description of Sampling, ASTM C 172. The examinee is judged on their ability to correctly perform or describe all of the required procedures of the ACI Performance Checklist.

Recertification is necessary every five (5) years, and requires successful completion of both the written and performance examinations.

Additional Resources:

Additional program information can be found in ACI’s technician workbook (CP-1) and this resource may be purchased by visiting www.concrete.org.

Videos of each of the test methods utilized in this program may be viewed by visiting Mississippi Concrete Association’s website, www.mississippiconete.com.

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SECTION 1

ASTM C1064 - Temperature of Freshly Mixed Portland-Cement Concrete

INTRODUCTION

Temperature of concrete is measured to ensure that the concrete is delivered in accordance with requirements provided in the the Project Documents. Concrete sets and hardens due to the chemical reaction between the cementitious materials and water. This chemical reaction is called hydration. Hydration like most chemical reactions is influenced by temperature. As temperature increases, hydration increases. As temperature decreases, hydration decreases. As concrete temperature approaches 32 degrees Fahrenheit, the water on in concrete could freeze. For these reasons, Project Documents provide a minimum concrete temperate that is dependant upon ambient temperature as well as the size of the concrete structure being constructed. This minimum temperature is specified to provide favorable temperatures for hydration to occur during the early life of the concrete. On the other hand, high temperatures contribute to faster setting concrete and also has influence on evaporation rates on free water in the concrete. The higher the concrete temperature, the higher the evaporation rates of this water. High evaporation rates increases the potential for plastic shrinkage cracking to occur in the concrete surface.

STUDY QUESTIONS

ASTM C1064 - Temperature of Freshly Mixed Portland-Cement Concrete

1. Thermometers used to measure the temperature of freshly mixed concrete must be capable of measuring temperatures throughout a range of 30° to 120° F. True or False
2. Thermometers used to measure the temperature of freshly mixed concrete shall be capable of accurately measuring the temperature to $\pm 1^\circ$ F. True or False
3. Reference thermometers used to verify the accuracy of thermometers used to test temperature of freshly mixed concrete shall be capable of accurately measuring temperature to $\pm 0.5^\circ$ F. True or False?
4. Verify the accuracy of thermometers in a oil or other suitable bath liquid at two temperatures at least _____° F apart.
5. Reject the thermometer if it differs in reading by _____°F from the reference temperature measuring device at either temperatures.
6. Provide at least _____ in. of concrete cover in all directions around the sensor of the thermometer and submerge the thermometer a minimum of _____ in. into the freshly mixed concrete.
7. Leave the thermometer in the freshly mixed concrete for a minimum of _____ minutes and a maximum of _____ minutes.
8. Report the temperature of freshly mixed concrete to the nearest 0.5° F. True or False
9. Check the accuracy of the thermometer every three months or whenever there is a question of accuracy. True or False?
10. To prevent ambient air temperature from affecting the reading, close the void left by inserting the thermometer by gently pressing the surface of the concrete around the thermometer. True or False?

SUMMARY OF TEST

ASTM C1064 - Temperature of Freshly Mixed Portland-Cement Concrete

1. Composite sample is not required if the only purpose is to determine temperature.
2. Insert the thermometer into the concrete a minimum of 3 in., with 3 in. of concrete on all directions.
3. Gently press concrete around thermometer, closing all air voids.
4. Wait at least 2 minutes, but no more than 5 minutes.
5. Read temperature before removing thermometer from concrete.
6. Report to the nearest 1°F.

SECTION 2

ASTM C172 - Sampling Freshly Mixed Concrete

INTRODUCTION

It is important to obtain a sample of concrete that is representative of the batch to before perform testing of freshly mixed concrete. This standard test method provides procedures that, if followed, will ensure a representative sample. Procedures contained herein require samples to be taken from the middle portion of the batch. This is due to the fact that concrete near the first and final portions of the batch are not representative. In order to sample from the middle portion, at least 10 percent of the batch should be discharged into the forms before collecting two samples. This will necessitate performing preliminary checks of the slump, temperature, and air content from the first portion of the load before concrete is discharged into the transporting equipment or forms. If these fresh properties meet requirements established in the Project Documents, discharge the first 10 percent of the batch. If the slump, temperature, and air are not within tolerances of the Project Documents, made adjustments by adding water and/or chemical admixtures in accordance with the Project Documents and re-run the preliminary checks. When the fresh properties meet project requirements discharge into the forms or transporting equipment. Collect two or more sample from the middle of the batch to combine into a composite sample for making strength specimens, along with slump, temperature, air concrete, and density.

STUDY QUESTIONS

ASTM C172 - Sampling Freshly Mixed Concrete

1. The elapsed time between obtaining the first and final portion of samples that will be used to fabricate a composite sample shall not exceed _____ minutes.
2. The individual samples shall be combined and remixed with a scope the minimum amount necessary to ensure uniformity. True or False?
3. Start testing for slump, temperature, and air content within _____ minutes after obtaining the final portion of the sample.
4. Start molding strength specimens within _____ minutes after fabricating the composite sample?
5. The minimum size of the sample of the sample when making strength specimens is _____ cubic foot.
6. Describe procedures for sampling concrete from a stationary mixer (except paving mixer), revolving drum mixer, or continuous mixer.
7. When sampling from paving mixtures, wait until contents of the mixer have been discharged and sample from at least _____ portions of the pile.
8. After fabricating a composite sample from a continuous mixer, wait a minimum of _____ minutes and a maximum of _____ minutes before beginning the tests.
9. The process of removing aggregates that are larger than appropriate for the size of the molds or equipment used is called _____.
10. When removing aggregates that are larger than appropriate for the size of the molds or equipment used, mortar adhering to the aggregate retained on the sieve shall be placed into the batch and mortar adhering to the sieve shall be discarded. True or False?

SUMMARY OF TEST

ASTM C172 - Sampling Freshly Mixed Concrete

1. When sampling concrete from a revolving drum mixer, what must happen before taking the sample?
All water and admixtures have be added and thoroughly mixed.
2. Describe procedures for sampling concrete from a revolving drum truck mixer.
Collect two or more portions at regularly spaced intervals from the middle of the batch.
3. Describe procedures for obtaining a sample from a discharge stream.
Pass a receptacle completely through the discharge stream or completely diverting the discharge stream into a sample container.
4. Describe the procedure for sampling concrete from a paving mixer.
Sample the concrete from at least five different portions after contents of the paving mixer has been discharged.
5. What is the minimum sample size to obtain if strength specimens are to be fabricated?
1 cubic foot
6. What if the time limit for obtaining two or more portions of concrete to be used to fabricate a composite sample?
15 minutes
7. What is the next step after collecting two or more samples?
Remix samples with a shovel to form a composite sample.
8. What is done to remove aggregates larger than appropriate for the size of molds or equipment used?
Wet sieving
9. After obtaining the final portion of the sample, what is the time limit for starting slump, temperature, and air content tests?
5 minutes
10. What is the time limit for starting fabrication of strength specimens after obtaining a composite sample?
15 minutes
11. Protect the sample from what?
sun, wind, and other sources of rapid evaporation, and from contamination

SECTION 3

ASTM C143 - Slump of Hydraulic Cement Concrete

INTRODUCTION

The slump test is used to measure the stiffness or fluidity of concrete. The stiffer the concrete is, the harder it is to place in forms and the more fluid the easier it is to put in forms. The required slump is primarily dependent upon the equipment used to place and consolidate the concrete. Slipform equipment requires a low slump in order for the concrete to maintain its shape after the forms are removed. Hand methods of placing and consolidating concrete generally require a higher slump. The slump test is also important in determining how consistent the concrete supplier is producing concrete. Higher ranges of slumps being produced may mean that the amount of mix water being used is not consistent. This variation in slump resulting from inconsistency in water may influence the set time and make finishing operations more difficult. In addition, concrete mixtures are proportioned to produce the specified strength at a given slump range. Therefore, slump is checked in the field to verify that the concrete is being produced at an acceptable range that is mostly likely to produce the specified strength if other fresh properties are also within their acceptable range.

STUDY QUESTIONS

ASTM C143 - Slump of Hydraulic Cement Concrete

1. A concrete mixture that is designed to produce a 10 in. slump can be tested in accordance with ASTM C143. True or False?
2. Check that the slump cone dimensions are in conformance with ASTM C143 when it is purchased or placed into service and at least every three months afterwards. True or False?
3. Metal molds shall have a minimum average thickness of _____ in.
4. A metal roll up tape may be used to measure the slump if it is marked in increments of _____ in. or smaller.
5. Fill the slump cone in two layers of equal volume. True or False?
6. Rod each layer of the slump 25 times and lightly tap the sides 10 to 15 times with an open hand to ensure no damage to the slump cone. True or False.
7. After filling and striking off the slump cone, raise the slump cone 12 in. in _____ seconds with a steady upward lift with no lateral or torsional motion.
8. Complete the slump test from start to finish within _____ minutes.
9. Measure the slump by measuring the distance from the base plate handle to the original displaced center. True or False?
10. Strike off the top of the slump with a screeding motion of the tamping rod. True or False?

SUMMARY OF TEST

ASTM C143 - Slump of Hydraulic Cement Concrete

1. Dampen the mold and base plate.
2. Clamp the slump cone to the base plate.
3. Fill the slump cone in 3 equal layers by volume (heights of 2 5/8 in. for first layer and 6 1/8 in. for second layer). Move the scoop around the perimeter of the mold opening to ensure an even distribution of the concrete.
4. Rod each layer 25 times using a smooth 5/8 in. diameter rod with rounded tip. Rod each layer throughout its depth and penetrate the underlying layer by approximately 1 in.
5. When rodding the top layer, add additional concrete, if necessary, to maintain an excess above the top of the mold at all times.
6. Strike off the top of the cone with the rod.
7. Remove all excess material from the base of the mold.
8. With a steady upward lift, remove the mold in 3 to 7 seconds.
9. Measure from the height of the inverted slump cone placed on the base plate (not on the ground beside the base plate), and measure from the bottom of the rod placed across the cone down to the displaced center of the top surface of the slumped concrete.
10. Report to the nearest 1/4".
11. Must complete test in less than or equal to 2 1/2 minutes.

SECTION 4

ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric)

INTRODUCTION

Density testing is required each time strength specimens are fabricated. Each concrete mixture is proportioned with a set of materials with known weights and volumes. These weights and volumes are used to determine the density of a specific concrete mixture. Changes in density may be attributed to multiple factors including; 1) air content (the higher the air content the lower the density, the lower the air content the higher the density), 2) changes in weights of materials, 3) changes in specific gravity of materials. Therefore, the density test is one way of determining if the approved mixture has been produced. Density can assist in trouble shooting in case the specified strength is not met and this is most likely the reason density is required when strength specimens are fabricated. Density can also be used to calculate yield of a truck load or truck loads of concrete. Yield can be determined by dividing the weights of all materials batch (pounds) by the density. Density can also be used to estimate the air content of freshly mixed concrete.

STUDY QUESTIONS

ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric)

1. When internal vibration is used to consolidate concrete for the density test, the frequency shall be at least _____ vibrations per minute.
2. The size of the measure used to test density is influenced by the slump of the concrete. True or False?
3. A glass or acrylic strike-off plate shall be at least _____ in. thick with a length and width at least 2 in. greater than the diameter of the measure.
4. Given a 3 in. slump measured for the concrete, what method(s) may be used to consolidate concrete in the measure?
5. If rodding is the method used to consolidate the concrete, how many rods per layer are used? _____
6. If internal vibration is the method used to consolidate the concrete, how many layers are used and how many insertions of the vibrating element? _____, _____.
7. After the concrete is consolidated by internal vibration, tap the sides of the measure 10 to 15 times with a mallet to close any voids left from withdrawing the vibrating element True or False?
8. On completion of consolidation, concrete protruding approximately 1/8 in. above the top of the mold is optimum. If needed, an amount of concrete can be added or an amount of concrete can be removed after striking-off the top surface with a strike-off plate to correct deficiency or excess. True or False?
9. Given the following:
Measure filled with concrete (Mc): 43.50 lbs
Mass of empty measure (Mm): 8.05 lbs
Volume of measure (Vm): 0.25 ft³
Calculate density (D): _____ (lbs/ft³)
10. Given the following weights on a concrete truck:
Cement: 4800 lbs
Gravel: 14,400 lbs
Sand: 8800 lbs
Water: 2150 lbs
Density (D): 145.1 lbs/ft³
Calculate Yield (Y): _____ yd³
11. Given the following:
Yield (Y): 7.9 yd³
Design yield (Yd): 8.0 yd³
Calculate relative yield (Ry): _____ yd³

STUDY QUESTIONS (continued)

ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric)

12. Given the following:
Theoretical airfree density (T): 150.1 lbs/ft³
Density (D): 144.5 lbs/ft³
Calculate air content (A): _____ %

SUMMARY OF TEST

ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric)

1. Dampen and weigh the empty measure.
2. Fill the measure in 3 equal layers.
3. Rod each layer 25 times using a smooth 5/8 in. diameter rod with rounded tip.
4. Rod each layer throughout its depth and penetrate the underlying layer by approximately 1 in.
5. After each rodding tap the sides of the measure 10-15 times with a mallet to close holes or voids left by the rodding.
6. Use a strike off plate to remove excess concrete.
7. Clean off the flange and any concrete on the measure.
8. Determine the full weight of the measure and concrete.
9. Determine the net weight of the concrete by subtracting the empty measure weight from the full measure weight.
10. Divide net weight by the volume of the measure.
11. Report density to the nearest 0.1 lb/ ft³.

SECTION 5

ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method

INTRODUCTION

The pressure meter is used to determine the air content of freshly mixed concrete. Microscopic size air bubbles are purposefully entrained in the paste of concrete that is exposed to repeated freezing and thawing cycles in a moist environment. These bubbles create air voids in the paste that provide space for freezing moisture to expand into instead of imposing stress in the concrete paste. There are two types of pressure meters including Type A and Type B. Type B pressure meters are more commonly used. The pressure meter is used to test normal weight and heavy weight concrete. Pressure meters are not used to test air content of concrete made with lightweight aggregates, air air-cooled blast furnace slag, or aggregates with high porosity. The pressure meter also cannot be used in non-plastic concrete typically used for manufacturing concrete pipe and masonry units. The percentage of air generally required for freezing and thawing durability is in a range of 3% to 7 1/2 %. The project specific air content should be included in the Project Documents and is influenced by nominal maximum size of coarse aggregate and freezing and thawing conditions.

STUDY QUESTIONS

ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method

1. The pressure meter is used to determine the air content of concrete made with any type of aggregate. True or False?
2. Never use an internal vibrator to consolidate concrete for the pressure because vibration may cause segregation and loss of intentionally entrained air. True or False?
3. After each layer is consolidated, always tap the sides 10 to 15 times with a mallet to close any voids left from consolidating. True or False?
4. Always use a strike-off bar to strike of the surface of concrete in the measuring bowl.
5. After strike-off, attached the cover assembly and add water through one petcock until _____ emerges from the opposite petcock.
6. Close both petcocks before pumping air into the air chamber. True or False?
7. Pump the air pressure in the air chamber to zero before releasing the air from the air chamber into the measuring bowl. True or False?
8. Read the air content on the gauge to the nearest 0.1% and record this as the final reading. True or False?
9. Release the air by opening _____ before removing the cover.
10. Given the following:
Apparent air content of the air tested (A1): 4.5%
Aggregate correction factor (G): 0.2%
Calculate air content of sample (G): _____ %

SUMMARY OF TEST

ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method

1. Fill the measure in 3 equal layers.
2. Rod each layer 25 times using a smooth 5/8 in. diameter rod with rounded tip.
3. Rod each layer throughout its depth and penetrate the underlying layer by approximately 1 in.
4. After each rodding tap the side of the cylinder 10-15 times with a mallet to close holes or voids left by rodding.
5. Use a strike off plate or a strike off bar to remove the excess concrete.
6. Clean off the flange and any concrete on the measure.
7. Attach the top of the air meter.
8. Add water through one petcock until water emerges from the opposite petcock. Jar meter to remove all air bubbles.
9. Pump air into the chamber to the initial pressure line, allowing a few seconds for the gauge hand to stabilize. If necessary, use the air bleeder valve and tap the gauge by hand to stabilize at the initial pressure line.
10. Close both petcocks.
11. Release the air in the air chamber and tap the sides of the measure smartly with the mallet.
12. Stabilize the gauge by lightly tapping by hand. Read the percentage of air on the dial and release the air valve.
13. Report total air to the nearest 0.1%.

SECTION 6

ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method

INTRODUCTION

The volumetric method may be used to determine the air content of freshly mixed concrete. Microscopic size air bubbles are purposefully entrained in the paste of concrete that is exposed to repeated cycles of freezing and thawing while in a moist environment. These bubbles create air voids in the paste that provide space for freezing moisture to expand into instead of imposing stress in the paste. The volumetric method may be used to test concrete made with any type of aggregates whether dense, cellular, or lightweight. The percentage of air generally required for freezing and thawing durability is in a range of 3% to 7 1/2 %. The project specific air content should be included in the Project Documents and is influenced by nominal maximum size of coarse aggregate and freezing and thawing conditions.

STUDY QUESTIONS

ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method

1. The volumetric method may be used to determine the air content of freshly mixed concrete made with any type of aggregate. True or False?
2. The purpose of adding isopropyl alcohol as the meter is initially being filled with water is so that after the first or subsequent rolling's little or no foam collects in the graduated neck. True or False?
3. If more foam than equivalent to _____ percent air above the water level the test is considered invalid.
4. Correction factors for the effect of isopropyl alcohol is zero when the amount of alcohol added is less than or equal to _____.
5. When the slump is less than 1 in. use internal vibration to consolidate the concrete for the volumetric method. True or False?
6. Fill the measuring bowl in three layers of equal volume. True or False?
7. After consolidation of the concrete, strike off excess concrete with a steel or high-density strike-off bar. True or False?
8. Insert the funnel and add approximately one pint of isopropyl alcohol to the fresh concrete before filling with water. True or False?
9. Repeat the inverting, shaking, and upright process for a minimum of _____ seconds and until the concrete has broken free from the measuring bowl. Do not keep meter inverted for more than _____ seconds at a time.
10. After completing the inverting, shaking, and upright process, tilt the meter approximately 45 degrees and vigorously roll the meter for approximately _____ minute(s).
11. The liquid level is considered stable when it does not change by more than _____% within 2 minutes.
12. Given the following:
Final meter reading (AR): 3.25%
Correction factor (C): 0.25%
Number of calibrated cups (W): 0
Calculate air content (A): _____%

SUMMARY OF TEST

ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method

1. Dampen interior of bowl.
2. Place concrete in the bowl in two layers of equal volume, while ensuring an even distribution of concrete.
 - a. Rod each layer 25 times.
 - b. Rod each layer throughout its depth and penetrate the underlying layer by approximately 1 in.
 - c. After each rodding, tap sides of the measure 10-15 times with a mallet.
3. After tapping the second layer 1/8 in. or less of concrete above the rim is optimal. Add or remove a representative sample of concrete as necessary.
4. Strike-off concrete and wipe the flange of the measuring bowl clean.
5. Wet the inside of the top section of the meter and attach it to the bowl.
6. Insert funnel then add at least 1 pint of water followed by alcohol. Record the amount of alcohol added.
7. Continue adding water until the water and alcohol level (bottom of meniscus) is level with the zero mark.
8. Attach and tighten the cap.
9. Invert and shake meter horizontally, then return to the upright position. Do not invert for more than 5 seconds at a time.
10. Repeat step 9 for a minimum of 45 seconds.
11. Tilt the meter approximately 45 degrees and roll the meter $\frac{1}{4}$ to $\frac{1}{2}$ turn forward and back several times.

SUMMARY OF TEST (Continued)

ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method

12. Turn bowl about 1/3 turn and repeat the rolling procedure in step 11.
 13. Repeat Steps 11 and 12 for approximately 1 minute.
 14. Set meter upright, loosen the cap and allow the liquid level to stabilize.
 15. When stable, read the water level to the nearest 0.25%. Record the initial meter reading.
 16. Re-tighten the cap and repeat Steps 11, 12, 13, and 14. Then proceed to Step 17.
 17. When the liquid level for the second reading is stable, read the level to the nearest 0.25%.
 18. If the second reading has not changed more than 0.25%, record the second reading as the final reading. Go to step 22.
 19. If the second meter has changed by more than 0.25%, record the second reading as the new initial reading and repeat steps 11, 12, 13, 14 and 15 then proceed to step 21.
 20. When the liquid level for the third reading is stable, read the water level to the nearest 0.25%.
 21. If the third reading has not changed more than 0.25% from the new initial reading, record the third reading as the final reading.
- Note 1:** If the third reading has changed by more than 0.25% from the second meter reading, discard the test.
22. Disassemble the meter to see if there is undisturbed, packed concrete in the bowl. If there is undisturbed concrete in the bowl the test is invalid.
 23. Air content equals final reading minus alcohol correction factor plus number of calibrated cups of water added. Report air content to nearest 0.25%.

SECTION 7

ASTM C31 - Making and Curing Concrete Test Specimens in the Field

INTRODUCTION

Strength is the primary way to specify concrete. Often times concrete is accepted or rejected based on strength test results from standard cured test specimens. Test specimens are typically 4 x 8 cylinders, 6 x 12 cylinders, or beams. Standard curing begins no later than 15 minutes after specimens have been fabricated. This standard curing requires a moist environment with a temperature between 60 and 80° F if the specified strength is less than 6000 psi. The initial curing temperature must be 68 to 78° F if the specified strength is 6000 psi or greater. This means that steps must be taken to keep the specimens moist and cool in the summer time and moist and warm in the winter. It's not an easy task to test and handle cylinders according to ASTM C31. Most likely the right way will take more time and cost a little more money. But, ASTM C31 is the standard and provides the guideline for all involved in the concrete industry. Deviations from this standard can cause significant differences in strength results.

STUDY QUESTIONS

ASTM C31 - Making and Curing Concrete Test Specimens in the Field

1. For acceptance testing for specified strength, cylinders shall be _____ or _____.
2. Unless otherwise specified by the specifier, beam molds shall be _____ in cross section.
3. If the slump of the concrete is greater than or equal to 1 in. the method of consolidation is either rodding or internal vibration and if the slump is less than 1 in. the method of consolidation is internal vibration. True or False.
4. Fill 4 in. x 8 in. cylinder molds with _____ of approximately equal volume and rod each layer with _____ rods per layer using a 3/8 in. diameter rod.
5. Fill 6 in. x 12 in. cylinder molds with _____ of approximately equal volume and rod each layer with _____ rods per layer using a 5/8 in. diameter rod.
6. A 6 in. x 6 in. x 20 in. beam mold is being used to fabricate strength specimens for a 4 in. slump concrete. What is the number of rods per layer?
7. After each layer of the beam has been vibrated, tap the outside of the mold sharply at least 10 times and spade each layer of concrete along the sides and ends of the beam molds with a trowel or other suitable tool. True or False?
8. After cylinder specimens have been consolidated, strike off the surface with a tamping rod or a handheld float or trowel. True or False?
9. If strength specimens are not fabricated at the location of initial curing, move specimen immediately to place of initial curing after fabrication. True or False?
10. For concrete with a specified strength of 6,000 psi or less, maintain initial curing temperature between _____ °F and _____ °F.

SUMMARY OF TEST

ASTM C31 - Making and Curing Concrete Test Specimens in the Field

Note: This procedure is for 6 in. x 12 in. cylinder molds.

1. Using a scoop, place the concrete in the cylinder mold in three layers of equal volume, moving the scoop around the perimeter of the cylinder mold opening to ensure an even distribution of the concrete.
 - a. Rod each layer 25 times using a smooth 5/8 in. diameter rod with rounded tip.
 - b. Rod each layer throughout its depth and penetrate the underlying layer by approximately 1 in.
 - c. After each rodding tap the sides of the measure 10-15 times with a mallet to close holes or voids left by rodding.
2. Strike off the top using the tamping rod, handheld float or trowel.
3. Mark the specimen mold to positively identify them and the concrete they represent.
4. Move no later than 15 minutes after molding to the place of initial curing.
5. Store strength specimens in an environment that will maintain required initial curing temperatures and an environment that will control loss of moisture. See "Initial Curing of Strength Specimens Below."

Initial Curing of Strength Specimens

1. Cure all strength specimens in an area that is level and free of vibration.
2. For normal strength concrete, cure between 60° F and 80° F. For high strength concrete (6000 psi or greater), cure between 68° F and 78° F. Initial cure up to 48 hours.
3. Control loss of moisture. This can be accomplished by covering the cylinder with a plastic cap or plastic bag with rubber band.
4. Record the minimum and maximum temperature during initial curing.
5. Specimens shall not be transported until at least 8 hours after final set.
6. Transport strength specimens in less than 4 hours to the lab by means not to damage them.

STUDY MATERIALS

Answers To Study Questions

Testing Poster

ANSWERS TO STUDY QUESTIONS

SECTION 1: ASTM C1064 - Temperature of Freshly Mixed Portland-Cement Concrete

1. True
2. True
3. True
4. 30
5. 1
6. 3, 3
7. 2, 5
8. False, 1
9. False, at least annually
10. True

SECTION 2: ASTM C172 - Sampling Freshly Mixed Concrete

1. 15
2. False, use a shovel
3. 5
4. 15
5. 1
6. passing a receptacle through the entire discharge stream or by completely diverting the discharge strength into a sample container.
7. 5
8. 2, 5
9. wet sieving
10. False. Discard mortar adhering to the aggregate and put mortar adhering to the sieving equipment back into the batch.

ANSWERS TO STUDY QUESTIONS

Section 3: ASTM C143 - Slump of Hydraulic Cement Concrete

1. False, the slump test is not applicable for non-plastic (less than 1/2 in.) and non-cohesive (9 in. or more).
2. False. Check for specified dimensions when it is purchased or placed in service and at least annually.
3. 0.060 in.
4. $\frac{1}{4}$
5. False. Fill the slump cone in three layers of equal volume.
6. False. Rod only, do not tap.
7. 5 ± 2
8. $2 \frac{1}{2}$
9. False. Measure the vertical distance from the top of the mold to the displaced original center.
10. False. Strike off the surface by means of a screeding and rolling motion.

Section 4: ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric)

1. 9,000
2. False. The size of the measure is based on nominal maximum size of coarse aggregate.
3. $\frac{1}{2}$
4. Rodding or internal vibration
5. 25
6. 2, 3
7. False. Tapping the sized of the measure 10 to 15 times is only required when rodding is the method of consolidation.
8. False. A small amount of concrete can be added to current deficiency or an excess of concrete can be removed after consolidating and before strike-off.
9. $(43.50 \text{ lbs} - 8.05 \text{ lbs}) / 0.25 \text{ ft}^3 = 141.8 \text{ lbs} / \text{ft}^3$
10. $(4800 \text{ lbs} + 14400 \text{ lbs} + 8800 \text{ lbs} + 2150 \text{ lbs}) / (145.1 \text{ lbs} / \text{ft}^3 \times 27 \text{ ft}^3/\text{yd}^3) = 7.7 \text{ yd}^3$
11. $7.9 / 8.0 = 0.99$
12. $((150.1 \text{ lbs} / \text{ft}^3 - 144.5 \text{ lbs} / \text{ft}^3) / (150.1 \text{ lbs} / \text{ft}^3)) \times 100 = 3.7\%$

ANSWERS TO STUDY QUESTIONS

Section 5: ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method

1. False. The pressure meter is used to determine air content of concrete made with relatively dense aggregates.
2. False. Vibration may be used to consolidate pressure meter concrete when the slump is 1 to 3 in. Always vibrate when the slump is less than 1 in.
3. False. Tapping the sides with a mallet is only required when consolidating by rodding.
4. False. A strike-off plate may be used instead of a strike-off bar. A strike-off plate must be used when pressure meter measuring bowl to determine density.
5. Water. Continue adding water until all air bubbles cease emerging from the opposite petcock and only water is observed coming out of the petcock.
6. False. Close both petcocks after pump the air in the air chamber up to the initial pressure line and before releasing the pressure into the measuring bowl.
7. False. Pump the air up to the initial pressure line. This initial pressure is determined during the calibration check of the meter.
8. False. Always subtract the aggregate correction factor from the apparent air content of the air tested.
9. both petcocks
10. $4.5\% - 0.2\% = 4.3\%$

ANSWERS TO STUDY QUESTIONS

Section 6: ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method

1. True
2. True
3. 2
4. 2 pints
5. False. Internal vibration is not allowed for the volumetric method.
6. False. Fill the measuring bowl two layers of approximately equal volume.
7. True
9. False. Add approximately one pint of water before adding the selected amount of isopropyl alcohol.
9. 45, 5
10. 1
11. 0.25
12. $(3.25\% - 0.25\% + 0) = 3.00\%$

Section 7: ASTM C31 - Making and Curing Concrete Test Specimens in the Field

1. 4 in. x 8 in. or 6 in. x 12 in.
2. 6 in. x 6 in.
3. True
4. 2 layers, 25
5. 3 layers, 25
6. $(6 \text{ in.} \times 20 \text{ in.}) / 2 \text{ in.}^2 = 60 \text{ rods}$
7. False, Spading is only required if rodding is the method of consolidation.
8. True
9. False. Move no later than 15 minutes after molding operations.
10. 60, 80

TESTING BASICS FOR FRESH PROPERTIES OF CONCRETE

- Obtain the sample in accordance with ASTM C 172.
- Once the individual samples are obtained from the middle portion of the load, remix to form a composite sample of at least 1 ft³ prior to testing (typically 2 ft³ – 3 ft³).
- Temperature, slump, and air must be started within 5 minutes of obtaining the final portion to make the composite sample.
- Casting of strength specimens must be started within 15 minutes of fabricating composite sample.
- As per ASTM C-94, field testing technician must be a certified technician in accordance with ASTM C 1077.
- All equipment must be pre-wet prior to testing, except for strength specimen molds and thermometers.
- All equipment must be calibrated at least at the frequency specified in the ASTM test methods, or whenever there is a question of accuracy.



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C 31

ASTM C 31 Concrete Test 4" x 8" Cylinders

(This procedure is for consolidation by rodding only with slump greater than or equal to 1" and coarse aggregate nominal maximum size of 1" or smaller. Vibration is required when slump is less than 1")

- Fill cylinder in 2 equal layers.
- Rod each layer 25 times using a smooth 3/8" rod with rounded tip.
- Rod each layer throughout its depth and penetrate the underlying layer by approximately 1".
- After each rodding tap the side of the cylinder 10-15 times with a mallet to close holes or voids left by the rodding.
- Strike off the top using the tamping rod, handheld float or trowel to produce a flat, even surface.
- Cover the cylinders with plastic cap or plastic bag with rubber band to prevent moisture loss and mark the date, time, psi of concrete, and set number on the side of the test mold.
- Move no later than 15 minutes after molding to the place of initial curing.

ASTM C 31 Concrete Test 6" x 12" Cylinders

(This procedure is for consolidation by rodding only with slump greater than or equal to 1". Vibration is required when slump is less than 1")

- Wet sieve out all aggregate larger than 2" through a 2" sieve.
- Fill cylinder in 3 equal layers.
- Rod each layer 25 times using a smooth 5/8" rod with rounded tip.
- Rod each layer throughout its depth and penetrate the underlying layer by approximately 1".
- After each rodding tap the side of the cylinder 10-15 times with a mallet to close holes or voids left by the rodding.
- Strike off the top using the tamping rod, handheld float or trowel.
- Cover the cylinders with plastic cap or plastic bag with rubber band to prevent moisture loss and mark the date, time, psi of concrete, and set number on the side of the test mold.
- Move no later than 15 minutes after molding to the place of initial curing.

ASTM C 31 Casting Flexural Beams

(This procedure is for consolidation by rodding only with slump greater than or equal to 1". Vibration is required when slump is less than 1")

- Fill the mold in two equal layers with the second layer slightly overfilling the mold.
- Consolidate each layer with the tamping rod once for every 2 sq. inches using a smooth 3/8" rod with a rounded end. (Example: 60 roddings per layer for a 6" X 6" X 20" beam.)
- Rod each layer throughout its depth. Rod the second layer throughout its depth, penetrating approximately 1" into the underlying layer.
- After rodding each layer, strike the mold 10 to 15 times with a mallet to close any holes left by rodding.
- Spade along the sides and end using a trowel or other suitable tool.
- Strike off to a flat surface using a handheld float or trowel to produce a flat, even surface.
- Move no later than 15 minutes after molding to the place of initial curing.



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C 31

ASTM C 1064 Concrete Temperature

- Composite sample is not required if the only purpose is to determine temperature, but sample must be a minimum of 1 ft³.
- Insert the thermometer into the concrete a minimum of 3", with 3" of concrete on all directions.
- Gently press concrete around thermometer, closing all air voids.
- Wait at least 2 minutes, but no more than 5 minutes.
- Read temperature before removing thermometer from concrete.
- Report to the nearest 1°F.



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C 1064

ASTM C 143 Slump Test

- Fill the slump cone in 3 equal layers by volume (heights of 2 3/8" for first layer and 6 3/8" for second layer).
- Rod each layer 25 times using a smooth 3/8" rod with rounded tip.
- Rod each layer throughout its depth and penetrate the underlying layer by approximately 1".
- When rodding the top layer, add additional concrete, if necessary, to maintain an excess above the top of the mold at all times.
- Strike off the top of the cone with the rod.
- Remove all excess material from the base of the mold.
- To aid in the determination of the displaced center, a small rock or coin may be placed in the center of the top surface before removing cone.
- With a steady upward lift, remove the mold in 3 to 7 seconds.
- Measure from the height of the inverted slump cone placed on the base plate (not on the ground beside the base plate), and measure from the bottom of the rod placed across the cone down to the displaced center of the top surface of the specimen.
- Report to the nearest 1/4".
- Must complete test in less than or equal to 2 1/2 minutes.



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C 143

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ASTM C 138 Concrete Density

(This procedure is for consolidation by rodding only with slump greater than or equal to 1" and a measure of a 1/2 cubic foot or less. Vibration is required when slump is less than 1")

- Weigh the empty measure.
- Fill the measure in 3 equal layers.
- Rod each layer 25 times using a smooth 3/8" rod with rounded tip.
- Rod each layer throughout its depth and penetrate the underlying layer by approximately 1".
- After each rodding tap the side of the cylinder 10-15 times with a mallet to close holes or voids left by the rodding.
- Use a strike off plate to remove excess concrete.
- Clean off the flange and any concrete on the measure.
- Determine the full weight of the measure and concrete.
- Determine the net weight of the concrete by subtracting the empty measure weight from the full measure weight.
- Divide net weight by the measure volume.
- Report density to the nearest 0.1 lb/ft³.



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C 138

ASTM C 231 Concrete Air Test Pressure Method Type B Meter

Not suitable for lightweight or highly porous aggregate
 (This procedure is for consolidation by rodding only with slump greater than or equal to 1". Vibration is required when slump is less than 1")

- Fill the measure in 3 equal layers.
- Rod each layer 25 times using a smooth 3/8" rod with rounded tip.
- Rod each layer throughout its depth and penetrate the underlying layer by approximately 1".
- After each rodding tap the side of the cylinder 10-15 times with a mallet to close holes or voids left by the rodding.
- Use a strike off plate or a strike off bar to remove the excess concrete.
- Clean off the flange and any concrete on the measure.
- Attach the top of the air meter.
- Add water through one petcock until water emerges from the opposite petcock. Jar meter to remove all air bubbles.
- Pump air into the chamber to the initial pressure line, allowing a few seconds for the gauge to stabilize. If necessary, use the air bleeder valve and tap the gauge by hand to stabilize at the initial pressure line.
- Close both petcocks.
- Release the air and tap the sides of the measure smartly with the mallet.
- Stabilize the gauge by lightly tapping by hand. Read the percentage of air on the dial and release the air valve.
- Report total air to the nearest 0.1%.



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C 231