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Center for Training
Transportation Professionals

Concrete Field

Testing Technician

Notebooks

Course Schedule

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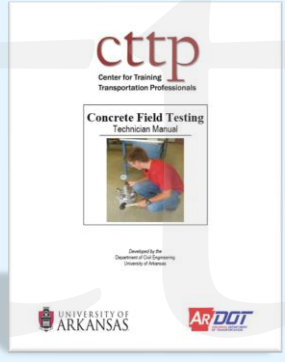

Presentation Tab
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Specifications Tab
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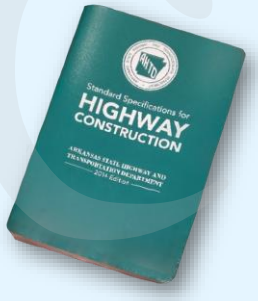
Notepad

Course Overview

ARDOT Specifications



Sampling
Temperature
Slump
Density
Air Content (Pressure)
Test Specimens
- **Cylinders & Beams**

Air Content (Volumetric)

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Exam Requirements

5 Year Certification
- **Written Exam**
- **Performance Exam**

Failure of Either Exam
- **Requires retake of failed exam within 1 year**
  - ~ **Entire written exam**
  - ~ **Entire performance exam**
  - ~ **If date is missed, student must retake both exams**
- **Student is responsible for rescheduling of retake**

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Written Exam

Questions
- **Standard Specifications**
- **Special Applications**

55 Questions
- **Multiple Choice**
- **True / False**
- **5 to 10 questions on each of the seven ASTM standards**

Limitations
- **1 Hour Exam**
- **Closed Book**

Minimum Passing Requirements
- **70 % Overall**
- **60 % Each Standard**

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Performance Exam

Passing Requirements
- **Successfully perform all seven standards in the laboratory**
  - ~ **Two trials are allowed per standard**
  - ~ **One additional retrial allowed per standard**
    - ~ Student must request retrial
    - ~ Proctor may not stop you
    - ~ Student retrial starts over at beginning of test

Failure to pass any standard within the allowable trials requires retaking of the entire performance exam

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Test Results

ACI test results are usually received within 1 month of testing

ACI test results will be sent by email

- **Overall written exam score**
- **Individual section scores**

CTTP only receives a pass/fail score for each student

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Recertification

5 Year Certification

- **Time starts from the completion date of all requirements**

Repeat Testing

- **Written Exam**
- **Performance Exam**

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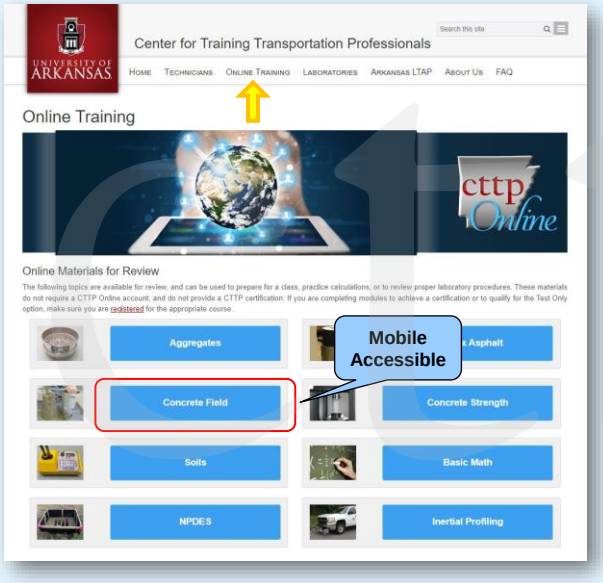

Help?

If you need help with mathematical calculations, just ask. Your instructor will be happy to assist you.

If you need further practice or assistance, please see our website www.cttp.org for online training.

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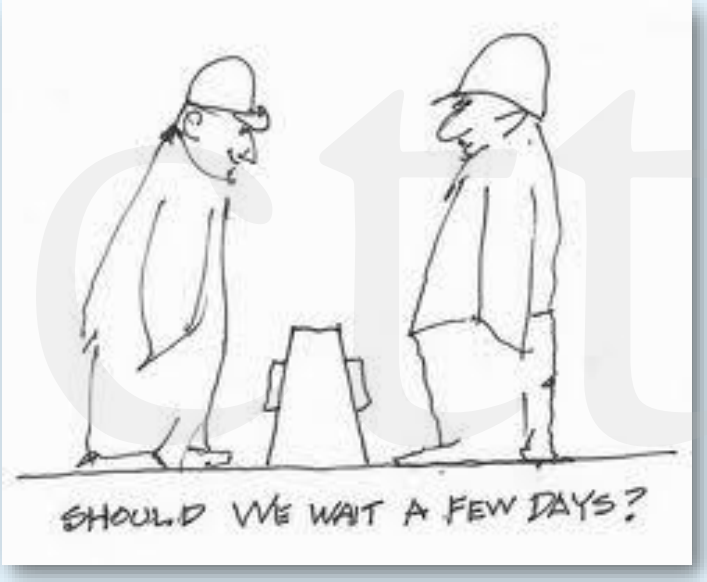

Why certify?

Would we all test the same way without the specifications to guide us?

Do specifications guarantee that we will all get the same result?

How does time affect our test results?

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Concrete What is it?

Aggregates

- Coarse
- Fine

Paste

- Portland Cement
- Water
- Entrapped Air
- Entrained Air

The paste hardens due to a chemical reaction taking place between the cement and water (hydration), binding the aggregates into a hard solid mass

Air - Entrained Concrete

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Temperature Effects on Concrete

Cold Weather

- **If concrete freezes while still fresh, the cement paste matrix is disrupted causing up to a 50% loss in ultimate strength**
- **Increased set times**
- **Increased possibility of thermal cracking due to rapid cooling**

Hot Weather

- **Potential strength reduction due to high water demand**
- **Decreased set times**
- **Increased risk of shrinkage cracking**
- **Difficulty in controlling air content**

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ARDOT Specifications

ARDOT specification limits are considered absolute limits !

- **Observed or calculated values are not rounded for determination of compliance**
  - ~ **Compared directly with the limit**
  - ~ **Average values are rounded to the same # of significant digits**
- **Any deviation outside limits is non-compliance**
  - ~ **Failing test**

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ARDOT Specifications
Rigid Concrete Pavement

Acceptance – Section 501.04

- **Lot - 4000 yd³ Sublot – 1000 yd³**
- **Gradation (fine & coarse aggregate)**
  - ~ **1 ½" - # 8 Sieves ± 7 % from JMF**
  - ~ **# 16 - # 100 Sieves ± 4 % from JMF**
- **Aggregate Moisture Content**
- **Slump (≤ 2")**
  - ~ **Sampled after placement on grade but before consolidation**

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ARDOT Specifications
Rigid Concrete Pavement

Acceptance – Section 501.04

- **Air Content (Pressure) (4 % - 8 %)**
  - ~ **Sampled after placement on grade but before consolidation**
- **Compressive Strength (f'c @ 28 days) (≥ 4000 psi)**
  - ~ **Cored Specimens (AASHTO T 24) (28 – 90 days)**
    - ~ ≥ 3.70 inches in diameter
- **Thickness**
  - ~ **Cored Specimen (AASHTO T 24)**

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ARDOT Specifications
Structures

ARDOT Class	Typical Uses	Max. Agg. Size	Entrained Air Content	Strength @ 28 days
A	Wingwalls & Miscellaneous	1 ½"	None	2100
B	Mass Use	3"	None	3000
S	Piers, Floor Slabs, Box Culverts	1 ½"	None	3500 *5000
M	Miscellaneous Const.	1 ½"	None	2100
SEAL	Concrete deposited under Water	1 ½"	None	2100
S (AE)	Bridge Decks, Piers, Pavements, Box Culverts	1 ½"	6% ± 2%	4000 *5000
	* Required strength @ 28 days for pre-stressed members			

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ARDOT Specifications
Structures

Acceptance – Section 802.06

- **Lot - 400 yd³ Sublot – 100 yd³**
  - ~ **Class SAE – minimum 1 per structure/deck pour**
- **Gradation (fine & coarse aggregate) (500 yd³)**
  - ~ **Fineness modulus of coarse aggregate (± 20 points)**
  - ~ **If outside tolerance a new mix design is required**
- **Aggregate Moisture Content**
- **Slump**
  - ~ **1" - 4" for Classes A, B, S, and SAE**
  - ~ **4" – 8" for Seal Class**

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ARDOT Specifications
Structures

Acceptance – Section 802.06

- **Air Content (Pressure)**
  - ~ **4% - 8 % for Class SAE only**
- **Compressive Strength**
  - ~ **Cylinders**
    - ~ Minimum of 2 cylinders
    - ~ 4 x 8 or 6 x 12

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ARDOT Specifications
Structures

Temperature (802.16)

- **Bridge Decks**
  - ~ **Concrete batches with temperatures in excess of 90°F will be rejected**
- **Temperature of all concrete must be more than 50°F when placed**
- **Protection**
  - ~ **Maintain the temperature adjacent to the concrete at minimum of 50°F for at least 7 days**
    - ~ Bridges
    - ~ Box Culverts
    - ~ Retaining Walls

Concrete that has been frozen… shall be removed and replaced

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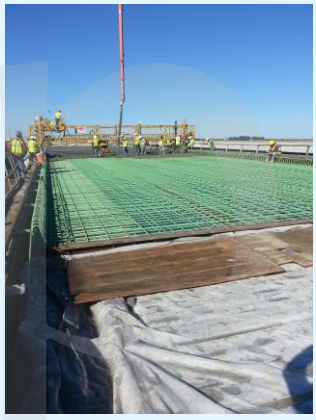
ARDOT Specifications
Structures

Pumping (802.10)

- **Samples for slump and air content are collected at the discharge end of the pipe**

0.5% to 1.0% loss of air content is typical but may be up to 50% of the air content going in



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ACI Concrete Field Testing Technician

Grade 1

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Sampling Freshly Mixed Concrete

ASTM C 172
AASHTO R 60

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Scope

Covers the procedures for obtaining representative samples of fresh concrete delivered to the jobsite

- **Samples may be used to determine compliance with specification requirements**

Covers the procedures to be used in wet-sieving

- **Removal of aggregates larger than a designated size**

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Sampling

Dampen container prior to obtaining sample

Obtain a composite sample unless only testing for temperature

- **Maximum time allowed between obtaining first and final portions of the composite sample is 15 minutes**

Sample 1
Sample 2
Sample X

15 minutes

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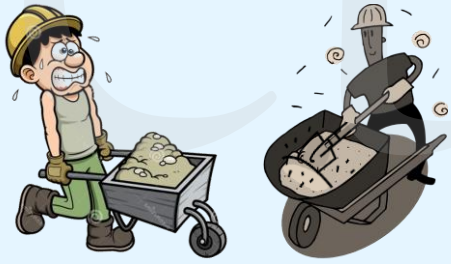
Sampling

Transport samples to place of testing

- **Wet-sieve if necessary**
- **Combine all sample portions**
- **Remix with a shovel to ensure uniformity**



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Pass the concrete over the designated sieve to remove oversized aggregate

Discard aggregate retained on the sieve

Scrape paste on sieve back into the remaining sample

Remix sample with a shovel to ensure uniformity before testing

Wet - Sieving

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Sampling

Within 5 minutes of obtaining the final portion of the composite sample, start tests for :

Temperature *Slump* *Air Content*

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Sampling

Start molding strength test specimens within 15 minutes after fabricating the composite sample

Cylinders *Beams*

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Sampling

Protect the sample from :

Sun

Wind

Other Sources of Rapid Evaporation

Contamination

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Procedure

Sample Sizes

- **Strength Test Specimens**
  - ~ **1 cubic foot (ft^3) minimum**
- **Temperature, Slump, & Air Tests**
  - ~ **Smaller sample sizes are permitted**
  - ~ **Size of sample is dictated by the maximum size of the aggregate**

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Procedure

Sampling should normally be performed as the concrete is delivered from the mixer to the conveying vehicle used to transport the concrete to the forms

- **Specifications may require other points of sampling**
  - ~ **Discharge end of concrete pump (ARDOT)**



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Procedure

Stationary Mixers

Stationary Batch Plant

Collect Sample

- **Collect two or more portions**
- **At regularly spaced intervals**
- **From the middle of the batch**

Obtain Portions

- **Pass a receptacle through the entire discharge stream**
- **Divert the entire discharge stream into a receptacle**

Combine portions into one composite sample

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Procedure

Revolving Drum Truck Mixers

Truck Mixer

To slow rate of discharge, slow the rate of drum revolution

Add all water and admixtures to mixer before sampling

- **This must be done to ensure obtaining a representative sample of the concrete being placed**

To slow the rate of discharge, slow the rate of drum revolution

- **Do not close gate openings or restrict the flow**

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Procedure

Revolving Drum Truck Mixers

Truck Mixer

Collect Sample

- **Collect two or more portions**
- **At regularly spaced intervals**
- **From the middle of the batch**

Obtain Portions

- **Pass a receptacle through the entire discharge stream**
- **Divert the entire discharge stream into a receptacle**

Combine portions into one composite sample

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Procedure

Continuous Mixers

Continuous Mix Truck

Make all adjustments to the mix

- Obtain sample after 5 ft³ or more of concrete has been discharged

Collect Sample

- Collect two or more portions
- At regularly spaced intervals
- From the middle of the batch

Obtain Portions

- Pass a receptacle through the entire discharge stream
- Divert the entire discharge stream into a receptacle

Combine portions into one composite sample

- Wait 2 – 5 minutes before testing

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Procedure

Paving Mixers

Concrete Paver

Discharge the contents of the paving mixer to grade

Obtain 5 or more sample portions from different areas of the pile

- Avoid contamination
- Avoid prolonged contact with an absorptive subgrade

Combine portions into one composite sample for testing

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Procedure

Open-Top Containers

Dump Truck

Take samples by the previous method that is most applicable under the given conditions

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Sampling Review

1. **What must occur before a sample of concrete can be taken from a revolving drum mixer?**

All water and admixtures must be added to the mixer

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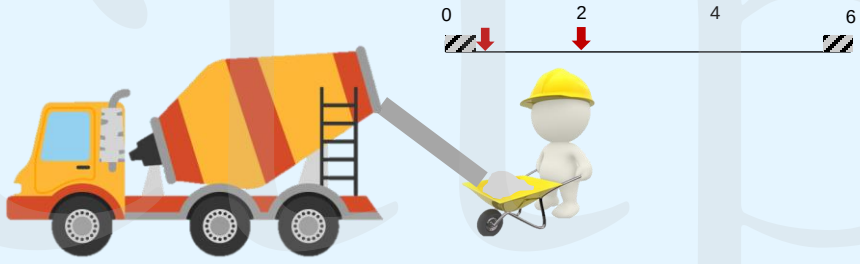
Sampling Review

2. **When sampling from a revolving drum mixer, what is collected and when is it taken during discharge?**



In two or more portions of concrete, at regularly spaced intervals, from the middle of the batch

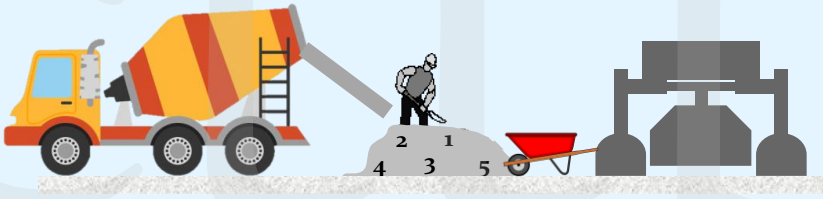
Sampling Review

3. **How are the sample portions obtained from the discharge stream of a revolving drum mixer?**

Repeatedly pass a receptacle through the entire discharge stream or completely divert the discharge stream into a sample container

Sampling Review

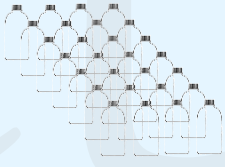
4. **Describe the procedure for collecting a sample from a paving mixer.**

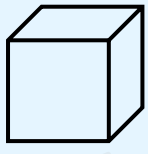


Discharge the contents of the paving mixer and obtain samples from at least five different portions of the pile

Sampling Review

5. **What is the minimum size for a sample when strength test specimens are to be molded?**





28 liters or 1 cubic foot

Sampling Review

6. **What is the maximum allowable time between obtaining the first and final portion of the composite sample?**

15 minutes

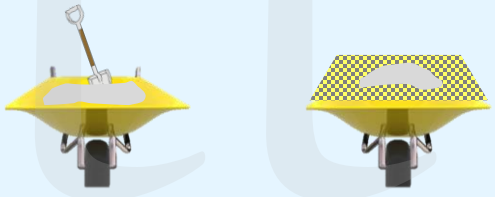
Sampling Review

7. **What action is required after the individual samples have been transported to the place where tests are to be performed?**

Combine and remix with a shovel

Sampling Review

8. **What should be done if the concrete contains aggregate larger than appropriate for the size of the molds being used?**



Wet-sieving

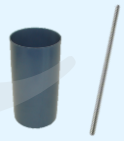
Sampling Review

9. **Start tests for slump, temperature, and air content within how many minutes after obtaining the final portion of the composite sample?**

5 minutes

Sampling Review

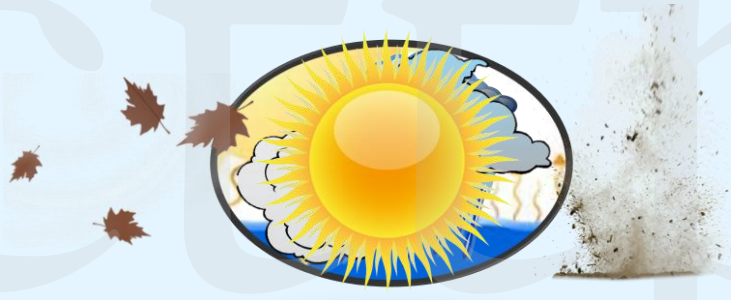
10. **Start molding specimens for strength tests within how many minutes after obtaining the final portion of the composite sample?**



15 minutes

Sampling Review

11. **From what must the concrete sample be protected?**



Sun, wind, rapid evaporation, contamination

Temperature of Freshly Mixed Concrete

ASTM C 1064
AASHTO T 309

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Introduction

Concrete temperature influences:

- **Quality**
- **Time of set**
- **Strength of concrete**
- **Performance of additives and admixtures**

Scope

- **Covers how to determine the temperature of freshly mixed hydraulic-cement concrete**
  - **Does not give specifications**

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Significance and Use

Typically used to verify conformance with temperature specifications

- **Concrete containing aggregate of a nominal maximum size greater than 3" may require up to 20 minutes for the transfer of heat from aggregate to mortar**
  - ~ **Time from batching to delivery usually exceeds this time and therefore additional wait time is rarely needed**

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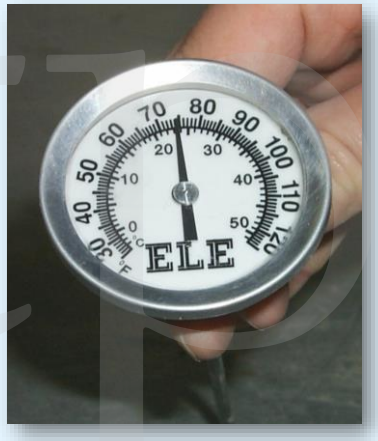
Apparatus

Temperature Measuring Device (TMD)

- **Capable of measuring to 1°F**
- **Temperature range of 30 – 120 °F**
- **Allow 3 inches or more of immersion**

Verify Accuracy:

- ~ **Annually**
- ~ **Question of accuracy**



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Verification Equipment

Reference Measuring Device

- **Readable and Accurate to 0.5°F**
  - ~ **Liquid in Glass Thermometers**
    - ~ Verify Once
  - ~ **Direct Reading Resistance Thermometers**
    - ~ Verify Yearly
- **Maintain records of accuracy in lab**
  - ~ Document NIST traceable reference standard used in verification

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Verification Equipment

Suitable Bath Liquid of Uniform Density

- **Maintain Constant Temperature**
  - ~ **± 0.5°F**
- **Continuously circulate liquid**

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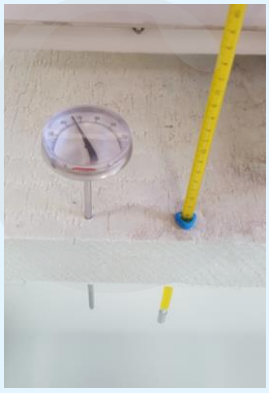
Thermometer Verification



Immerse both thermometers in bath for at least 5 minutes

- **Suspend thermometers so that neither are touching the sides or bottom of bath**

Record temperature readings of both thermometers

- **Thermometer must check within ± 1°F of reference thermometer**

Check @ 2 temperatures

- **≥ 30°F apart**

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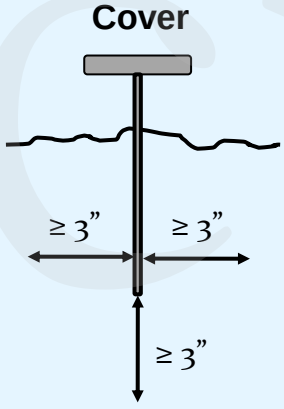
Procedure



Composite samples are <u>not</u> required if the only purpose is to determine temperature

Acceptable Locations

- **Transportation Equipment**
- **Forms**
- **Containers**

Cover (minimum)

- **Transport Equip. & Forms**
  - ~ **3 inches in all directions**
- **Containers :**
  - ~ **3 inches or 3 x NMAS** ***(whichever is greater)***

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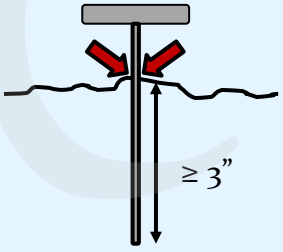
Procedure

Insertion



If using a container, dampen the container prior to obtaining the sample

Place the thermometer in the concrete so that the end of the temperature sensor is submerged a minimum of 3 inches

Close the void by gently pressing the concrete around the stem at the surface of the concrete

- **Prevents the ambient air temperature from affecting the reading**

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Procedure

Reading

68 °F

Wait 2 - 5 minutes

Read the thermometer

- **Leave TMD device in concrete to read**

Record temperature

- **Nearest 1 °F (0.5 °C)**

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Slump of Hydraulic-Cement Concrete

ASTM C 143
AASHTO T 119

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Introduction

Slump test measures the consistency of fresh concrete

- **Consistency – A measure of the relative fluidity of the concrete mixture**
  - **Lab conditions: an increase in water content increases slump**
  - **Field conditions: an increase in slump does not mean water content has increased**

Terminology :

- **Subsidence – to sink to a lower level (slump)**

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Significance and Use

Applicable to concrete having coarse aggregate up to 1½”

- **If aggregate is retained on 1½” sieve, wet sieve over 1½” sieve**

Test not applicable for:

- **Non-plastic concrete**
  - **Slumps < ½”**
- **Non-cohesive concrete**
  - **Slumps > 9”**

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Apparatus

Base Plate

- **Non-absorbent, rigid, flat, level**
- **Must release mold without movement of the mold**
- **Must contain all slumped concrete**

Tamping Rod

- **Round, smooth, straight steel**
- **5/8” ± 1/16” diameter**
- **At least 4” > mold depth but ≤ 24” in length**
- **Hemispherical tip(s)**

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Apparatus

Mold

Seamless & Rigid

Frustum of a cone

- **12” ± 1/8” High**
- **4” ± 1/8” Dia. Top**
- **8” ± 1/8” Dia. Base**

Mold shall be free from dents, deformation, or adhered mortar

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Apparatus

Mold

Verification

- **Check mold condition and all dimensions before 1st use and annually thereafter**
- **Metal Molds**
  - ~ **Average Thickness**
    - ~ ≥ 0.060 in.
  - ~ **Individual Thickness**
    - ~ ≥ 0.045 in.
- **ABS Plastic Molds**
  - ~ **Average Thickness**
    - ~ ≥ 0.125 in.
  - ~ **Individual Thickness**
    - ~ ≥ 0.100 in.

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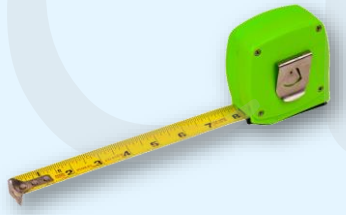
Apparatus

Measuring Device

Ruler or tape

- **≥ 12” Length**
- **¼” Divisions or smaller**



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Procedure

Dampen the mold and base

- **Place mold on a flat, level, non-absorbent, rigid surface free of vibration**

Stand on the foot pieces, or use a clamping arrangement during the filling of the mold

- **Prevent any movement of the mold during filling and prior to lifting of the mold**

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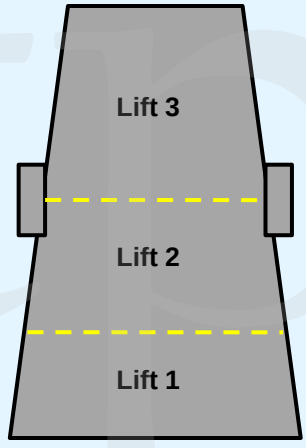
Procedure

Fill the mold in three layers of equal volume

- **Lift 1 2-5/8”**
- **Lift 2 6-1/8”**
- **Lift 3 Top**

Move scoop around perimeter opening when filling to ensure an even distribution of concrete



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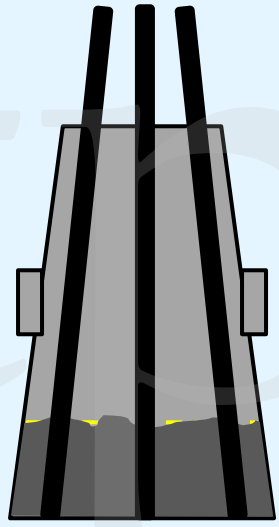
Procedure

Fill the mold to a depth of ≈ 2-5/8” with concrete

Rod the bottom layer using 25 strokes

- **Penetrate rod to the bottom**
- **Incline rod slightly for strokes around perimeter**
- **Spiral inward and use vertical strokes in center portion**



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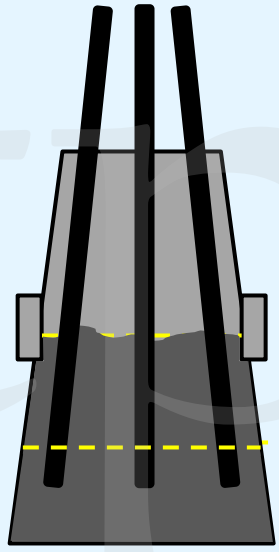
Procedure

Fill the mold to a depth of ≈ 6-1/8” with concrete

Rod the 2nd layer using 25 strokes

- **Penetrate rod through 2nd lift and 1 inch into the 1st lift**
- **Incline rod slightly for strokes around perimeter**



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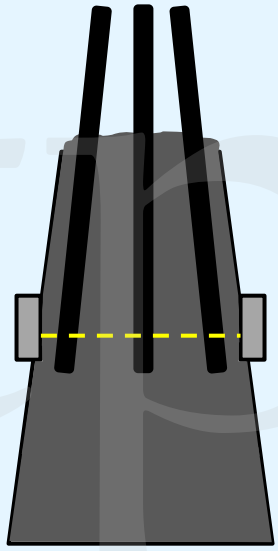
Procedure

Add concrete until the level is above the rim of the mold

Rod the 3rd layer using 25 strokes

- **Penetrate rod through 3rd lift and 1 inch into the 2nd lift**
- **Stop rodding and add concrete to keep the concrete level above the rim at all times**



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Procedure

- **Strike off top of mold using the tamping rod**
  - **Apply a rolling and screeding motion**

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Procedure

- **Remove concrete from base of mold to prevent interference with slumping concrete**
  - **Do not allow mold to move during this process**

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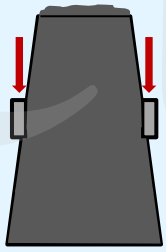
Procedure

Hold mold down firmly with handles

- **Accidental raising of the mold prior to the lift must not occur**



Step off foot pieces or release clamps

77

Procedure

Lift the mold vertically

- **Use a steady, upward lift to a height of 12”**
  - ~ **Avoid lateral or twisting motions**
- **Complete the raise in 5 ± 2 seconds**

Complete the test in 2½ minutes or less

- **Filling to mold removal**

78

Procedure

Measure slump

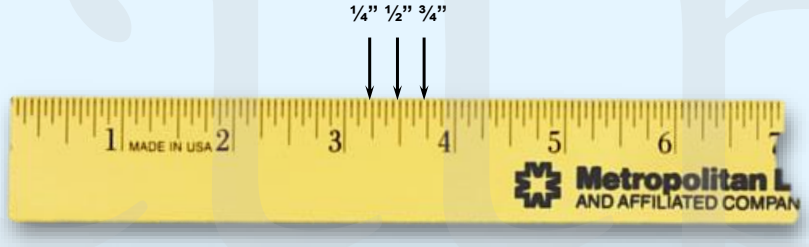
- **Vertical distance from the top of the mold to the displaced original center**
  - ~ **If a decided falling away or shearing occurs disregard the test and test another portion**

Normal Shear

79

Report

Report slump to the nearest ¼ inch



80

Report

81

Density (Unit Weight) of Concrete

ASTM C 138
AASHTO T 121

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84

Introduction

A change in density may indicate:

- **Change in air content**
- **Change in water content**
- **Change in cement content**

A change in density may affect:

- **Strength**
- **Resistance to chemicals**

85

Scope

Covers the determination of the density of freshly mixed concrete

- **Excludes non-plastic concrete**

Gives formulas for calculating:

- **Yield**
- **Relative Yield**
- **Cement Content**
- **Gravimetric Air Content**

86

Apparatus

Measure

Balance

- Accurate to 0.1 lb (45 g) or
- 0.3 % of test load (greater accuracy)

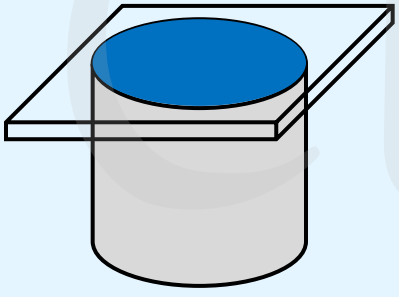
Measure

- Steel or suitable metal
- Capacity of measure is based on NMAS (Table 1 – ASTM C 138)
  - ~ Minimum size 0.2 ft^3
  - ~ May use pressure meter bowl if NMAS ≤ 1”
- Rim of air meter bowls must be plane within 0.01” (0.3mm)

87

Volume

Measure



Volume of Measure

- Determine using ASTM C 29
  - ~ Annually
  - ~ Reason to question accuracy
- Record volume of measure to 0.001 ft^3

88

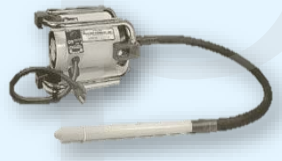
Consolidation Equipment

Tamping Rod

- 5/8 ± 1/16” steel
- Hemispherical tip
- At least 4” > mold depth but ≤ 24” in length

Internal Vibrator

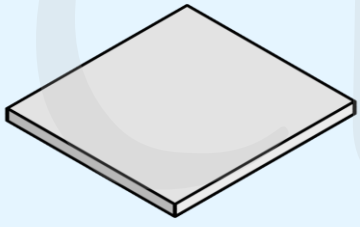
- Element ¾” – 1½” dia.
- Frequency ≥ 9000 vpm
  - ~ Verify frequency at least every two years with vibrating reed tachometer



89

Strike-Off Equipment

Flat Strike-Off Plate



Size

- Length & width at least 2” greater than the diameter of the measure

Metal, Glass or Acrylic

- Metal ≥ ¼” thick
- Glass or Acrylic ≥ ½” thick

Edges straight and smooth within 1/16”

90

Apparatus

Mallet

- **Size**
  - **1.25 ± 0.50 lb**
    - Measures ≤ 0.5 ft³
  - **2.25 ± 0.50 lb**
    - Measures > 0.5 ft³
- **Head**
  - **Rubber or Rawhide**

Scoop

- **Large enough to obtain representative scoops of concrete**
- **Small enough so concrete is not spilled during placement into mold**

91

Use

Perform density (unit weight) testing on the full mix

- **ASTM C 172 Section 6.1**

No wet sieving is to be performed for density testing

- **Obtain a properly sized measure for the NMAS of the concrete mixture**

92

Procedure

Consolidation method is based on slump unless the job requirements specify a specific method

Consolidation Method	Slump
Rod	> 3”
Rod or Vibrate	1” – 3”
Vibrate	< 1”

93

Procedure

Rodding

- **3 lifts**
- **Strokes based on the size of the measure**

Strokes / Lift	Size of Measure	Mallet Size
25	≤ 0.5 ft³	1.25 ± 0.5 lb
50	1.0 ft³	2.25 ± 0.5 lb
1 / 3 in.² Area	> 1.0 ft³	2.25 ± 0.5 lb

- **10 – 15 Taps / Lift**
  - ~ **Use enough force to close voids left by the tamping rod and release trapped air bubbles**

94

Procedure

Vibration

- **2 lifts**
- **3 Insertions per layer**
  - ~ **Apply vibration only until surface becomes smooth**
    - ~ Over vibration may cause segregation and loss of entrained air
- **No taps with mallet**

95

Procedure

Dampen the measure

- **Remove excess water**

Record the empty weight of the measure

96

Procedure

Filling

Note : The steps shown for filling and compaction assume a slump greater than 3 inches and a 0.250 cubic foot measure is being used

Fill the measure in 3 equal layers

- **Move the scoop around the perimeter while filling to limit segregation and obtain an even distribution of concrete**

97

Procedure

Rodding

Consolidate each layer of concrete by rodding 25 times per lift

- **Penetrate each previous lift by about 1”**

Tap each layer 10 – 15 times using the rubber mallet

- **Use enough force to close holes left by rodding**

98

Procedure

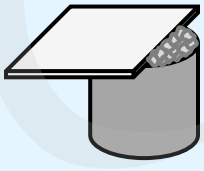
After consolidation, there should be about 1/8” (3mm) excess concrete above the top of the mold

- **After consolidation, adjust the top level if needed by adding or removing a representative portion of concrete**
  - ~ **Do not consolidate any additions**
- **Make all adjustments prior to strike-off**

99

Procedure

Strike - Off



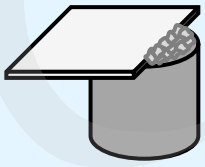
Strike - Off

- **Use only the strike-off plate**
- **Cover 2/3 of surface with the plate and pull back with a sawing motion**
  - ~ **Keep plate horizontal and in contact with the rim of the mold**

100

Procedure

Strike - Off



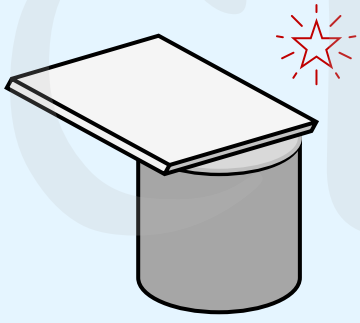
Strike - Off

- **Cover the same 2/3 area and push forward with a sawing motion**
  - ~ **Keep plate in a horizontal position and in contact with the mold rim until plate slides completely off the measure**
  - ~ Do not lift plate

101

Procedure

Strike - Off



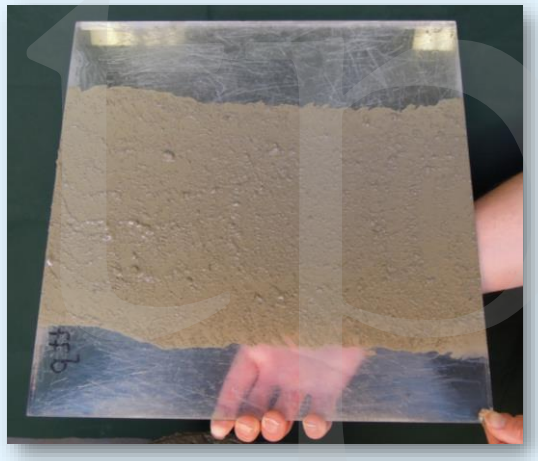
Strike Off

- **Incline the plate slightly to finish the concrete and <u>produce a smooth surface</u>**
  - ~ **Pull back in a smooth motion**
  - ~ **If low spots are visible, pull concrete toward low areas**

102

Procedure

Proper Strike - Off



103

Procedure

Clean Mold Exterior

- **Clean exterior completely**
  - **Remember to look at all sides and under handles**

104

Procedure

Record the weight of the full measure

Calculate density

$$D = \frac{W_c}{V_m}$$

Report density to nearest 0.1 lb/ft³

105

Calculation

Density
(Unit Weight)

The weight of concrete per unit volume of concrete

lb/ft³
kg/m³

$$D = \frac{W_c}{V_m}$$

Report Density to the nearest 0.1 lb/ft³

	Mass of Empty Measure	8.50	lb
	Mass of Full Measure	47.84	lb
W_c	Net Mass of Concrete	39.34	lb
V_m	Volume of Mold	0.250	ft³
	Reported Density	**157.4**	lb/ft³

$$D = \frac{39.34}{0.250} = 157.36$$

106

Density Calculation

Volume of Measure 0.249 ft³

$$D = \frac{W_c}{V_m}$$

Mass of Empty Measure	8.42	lb
Mass of Full Measure	45.19	lb
Net Mass of Concrete		lb
Reported Density (unit weight)		lb/ft³

107

Typical Batch Ticket

Material	Design Qty		Required		Batched	
CEMB12	352	lb	3168	lb	3170	lb
FLYASHC	88	lb	792	lb	790	lb
NATSAND	1491	lb	14023	lb	13980	lb
67LS	1650	lb	15147	lb	15200	lb
MICRO (Air)	0.40	/C	12.67	oz	12.00	oz
POZZ80 (Reducer)	3.50	/C	110.88	oz	112.00	oz
Water	30.0	gal	143.9	gal	144.0	gal
Load Totals			9.0	yd³	34349	lb

111

Calculation

Yield

$$Y = \frac{M}{(D \times 27)}$$

Report Yield to the nearest 0.1 y^3

M	Mass of Batched Materials	40,160	lb
D	Density of Concrete	146.3	lb/ft^3

The volume of concrete produced from a concrete batch

27 ft^3 = 1 yd^3

y^3
m^3

$$Y = \frac{40{,}160}{(146.3 \times 27)} = \frac{40{,}160}{3{,}950.1} = 10.166...$$

10.2 yd^3

112

Yield Calculation

$$Y = \frac{M}{(D \times 27)}$$

Mass of Batched Materials	38,651	lb
Density of Concrete	144.1	lb/ft^3

113

Calculation

Relative Yield

$$R_y = \frac{Y}{Y_d}$$

Report Relative Yield to the nearest 0.01

Y	Yield of Concrete	10.2 yd^3
Y_d	Designed Yield	10.0 yd^3

A ratio of concrete yield to the designed yield

$$R_y = \frac{10.2}{10.0} = 1.02$$

1.02

115

Relative Yield Calculation

$$R_y = \frac{Y}{Y_d}$$

Yield of Concrete	9.9 yd^3
Designed Yield	10.1 yd^3

116

Calculation

Cement Content

$$C = \frac{C_b}{Y}$$

Report Cement Content to the nearest 1 lb/yd³

The weight of cement per cubic yard or cubic meter of concrete produced

C_b	Weight of Cement in Batch	5,753 lb
Y	Yield of Concrete	10.2 yd³

$$C = \frac{5{,}753}{10.2} = 564.01\ldots$$

564 lb/yd³

118

Cement Content Calculation

$$C = \frac{C_b}{Y}$$

Weight of Cement in Batch	5,211 lb
Yield of Concrete	9.9 yd³

119

Calculation

Air Content (Gravimetric)

$$A = \frac{(T - D)}{T} \times 100$$

Report Air Content to the nearest 0.1 %

T	Theoretical Density	168.0 lb/ft³
D	Density of Concrete	157.4 lb/ft³

Calculated air content based on the theoretical density of the concrete batch

T = 0 % air basis

$$A = \frac{(168.0 - 157.4)}{168.0} \times 100$$

$$A = \frac{10.6}{168.0} \times 100 = 6.309\ldots$$

6.3 %

121

Air Content (Gravimetric) Calculation

$$A = \frac{(T - D)}{T} \times 100$$

Theoretical Density	153.2 lb/ft³
Density of Concrete	144.1 lb/ft³

122

Theoretical Density Calculation

Based on the total absolute volume (V_{ft^3}) and total mass (M_{lb}) of all ingredients

$$T = \frac{M}{V}$$

- ***V = M / (G x 62.4 lb/ft³)***
- ***G - Specific gravity***
  - ~ ***Use saturated surface dry (SSD) specific gravities and masses for all aggregates***

Report theoretical density to nearest 0.1 lb/ft³

124

Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 231
AASHTO T 152

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130

Introduction

Without enough air in the mortar fraction of concrete, normal concrete that is exposed to cycles of freezing and thawing may scale and/or spall, resulting in a durability failure of the concrete

Too much entrained air may cause a reduction in concrete strength

Scaling

Spalling

131

Scope

Determines the air content of freshly mixed concrete

- **Based on the change in volume of the concrete due to a change in pressure**

For use with relatively dense aggregates and mortars only

- **Requires an aggregate correction factor**

Not applicable to:

- **Non-plastic concrete, or concretes containing lightweight aggregates, air-cooled blast furnace slag, or high porosity aggregates**

132

Apparatus

Type A Meter

- Calibration affected by changes in barometric pressure or elevation

Type B Meter

133

Apparatus

Bowl

- Metal
- Diameter must be at least 0.75 to 1.25 times the height
- Minimum capacity is 0.20 ft^3
  - ~ Typical volume is 0.250 ft^3 for a Type B meter

Calibration Vessel

- ≈ 5 % of bowl volume

134

Apparatus

Tamping Rod

- 5/8 ± 1/16” steel
- Hemispherical tip
- 4” > mold depth but ≤ 24” in length

Internal Vibrator

- ≥ 9000 vpm
- ASTM C 192

135

Apparatus

Mallet

- Size
  - ~ 1.25 ± 0.50 lbs
    - ~ Measures ≤ 0.5 ft³
  - ~ 2.25 ± 0.50 lbs
    - ~ Measures > 0.5 ft³
- Head
  - ~ Rubber or Rawhide

Scoop

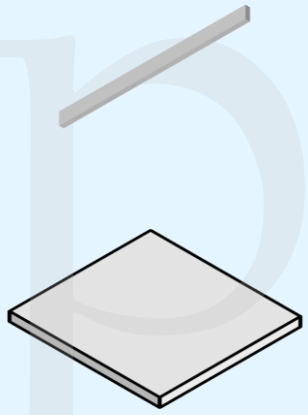
- Large enough to obtain representative scoops of concrete
- Small enough so concrete is not spilled during placement into mold

136

Apparatus

Strike-Off Bar

- Metal
- ≥ 1/8" thick, ¾" wide, & 12" long



Strike Off Plate

- Metal ≥ ¼" thick
- Glass or Acrylic ≥ ½" thick
- Length & Width at least 2" greater than the diameter of the measure
- Edges smooth within 1/16"

137

Calibration

Annex 1.2 to 1.5 – Once or to check

- A1.2 – Wt. of water to fill calib. vessel (ω)
- A1.3 – Weight of water to fill bowl (W)
- A1.4 – Calib. vessel % of bowl volume (R)

$$R = {}^{\omega}/_{W} \times 100 \text{ (type B meter)}$$

- A1.5 - Check of expansion factor (IP)

Annex 1.9 – Not to exceed 3 months

- A1.9 : Check of air pressure dial gauge

138

Calibration

Calibration Records

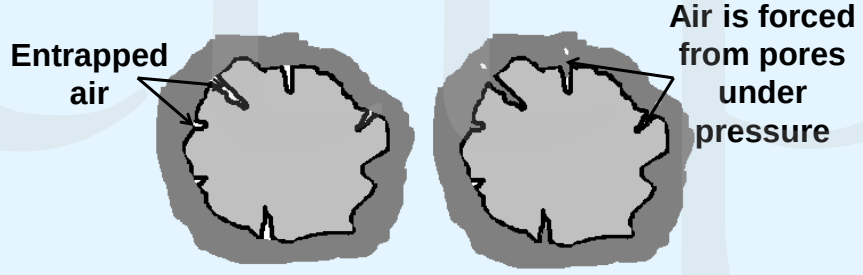
- **Determination of expansion factor**
- **Size of calibration vessel used**
- **Reading of the gauge at the calibration test point(s)**

Aggregate Correction Factor

Accounts for the surface porosity of the aggregate

Determined from a combined aggregate sample

- **Typical values range from 0.2% to 0.5%**



Procedure

If aggregate is retained on the 2"sieve, wet-sieve the concrete over an 1-1/2" sieve

Determine the consolidation method based on the slump of the concrete unless otherwise stipulated

Consolidation Method	Slump
Rod	> 3"
Rod or Vibrate	1" – 3"
Vibrate	< 1"

141

Procedure

Dampen bowl and fill with concrete according the requirements for the consolidation method :

Rodding	Vibration
3 layers	2 layers
25 strokes / layer	3 insertions / layer
10 – 15 taps / layer	No taps / layer

- **Penetrate previous layers by 1" during consolidation**
- **Never continue vibration long enough to cause the escape of froth from the sample**
- **Over vibration may cause segregation and the loss of entrained air**

142

Procedure

Strike-off Bar

Adjust level of concrete after consolidation of final layer

- **1/8” of excess concrete is optimal**
- **Adjust concrete level prior to strike off**

Strike-off the concrete surface

- **Strike-off Bar – use sawing motion**
- **Strike-off Plate – use same technique as in density test**

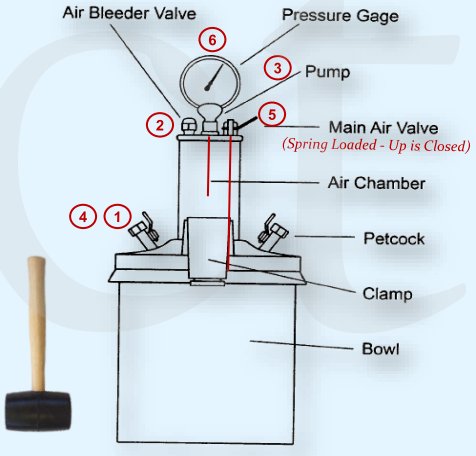
143

Procedure

Clean the rim of bowl

144

Type B Air Pressure Meter



1. Fill petcock with water
2. Close air bleeder valve (top nut)
3. Pump up to initial pressure
4. Close both petcocks
5. Open main air valve (lever)
6. Tap the bowl with mallet
7. Read dial to nearest 0.1%
8. Close main air valve (lever)
9. Open both petcocks (cover)

145

Procedure

Dampen the cover and clean the rubber gasket

Release any residual pressure shown on dial gauge

- **Accidently bumping the main air valve may cause failure during testing**

Open both petcocks and check for any blockage

146

Procedure

Attach cover assembly to provide a water-tight seal

- **Clamps should be adjusted if too tight or too loose**
- **Secure opposite clamps into position at the same time**
  - ~ **Assure that clamp fingers are fully under rim**

147

Procedure

Close the main air valve

Note: Main air valve is spring loaded and is closed unless held open

Using a syringe, inject water through a petcock until it emerges from the opposite petcock

- **Jar the meter gently while water is being added until all trapped air beneath the cover is expelled**

Close the air bleeder valve

- **Top nut**

148

Procedure

Pump air into the air chamber until the dial is on the initial pressure line

- **IP is found written on the dial face**
- **IP marks are below 0%**

Allow a few seconds for the compressed air to cool

149

Procedure

Tap the gage lightly with fingers until reading stabilizes

- **Adjust air to initial pressure line**
  - **Bleed air off by loosening the air bleeder nut**
  - **Pump additional air if needed**
  - **Tap gauge lightly after adjustments to stabilize needle**

150

Procedure

Close both petcocks

151

Procedure

Open the main air valve between the air chamber and the bowl (hold lever down)

- **Sharply tap the measure with mallet**
- **Do not let up on lever**

152

Procedure

Continue holding lever down

- **Drop mallet and lightly tap the dial gage with your fingers until reading is stable**

Read the dial gage

153

Procedure

Air Content ≤ 8.0 %

- **Report to nearest 0.1 %**

Air Content > 8.0 %

- **Report to nearest half-scale division**

154

Procedure

Close the main air valve (release lever)

- **Failure to close main air valve before releasing pressure from air chamber or container may result in water entering the air chamber**
  - ~ **If water enters air chamber, bleed water from air bleeder valve and then pump up and blow out air chamber**

Release pressure by opening <u>both</u> petcocks before removing cover

- **Cover both petcocks with your hands**

Remove cover

155

Calculation

Determine the reported air content

- **<u>Subtract</u> the aggregate correction factor (ACF) from the reading on the dial gage**

Measured Air Content	5.6 %
Aggregate Correction Factor	0.4 %
Reported Air Content	**5.2 %**

If wet sieved, calculate adjusted air content

156

Air Content Calculation

What is the reported air content ?

Measured air content	
Aggregate correction factor	
Reported air content	

157

Making and Curing Concrete Test Specimens in the Field

ASTM C 31
AASHTO R 100

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Center for Training Transportation Professionals

163

Introduction

Most concrete is bought and sold based on the strength of the concrete

Concrete strength test specimens must be made properly so that the:

- **Results are reliable**
- **Tests can be reproduced**
  - ~ **Deviation from standard procedures can cause significant differences in strength results**

164

Introduction

Concrete cylinders are made to test for:

- **Compressive Strength**
- **Splitting Tensile Strength**

Concrete beams are used to test for:

- **Flexural Strength**

165

Scope

Testing Requirements

Covers the procedures for making and curing, protecting, and transporting cylinder and beam specimens made from fresh concrete

Field Technicians making and curing specimens for acceptance testing shall meet qualifications of ASTM C1077

- **ACI Concrete Field Testing Technicians (Grade I)**
- **Or equivalent**

166

Sampling

Sample according to ASTM C 172 after all on-site adjustments have been made

- **Water**
- **Admixtures**

Record identification information

- **Placement location**
- **Time of casting**

Perform tests for temperature, slump, and air content

~ **Do not use concrete from air tests to make cylinders or beams**

167

Apparatus

Sampling Receptacle

- Heavy metal pan, wheelbarrow, or a large flat, clean and nonabsorbent board

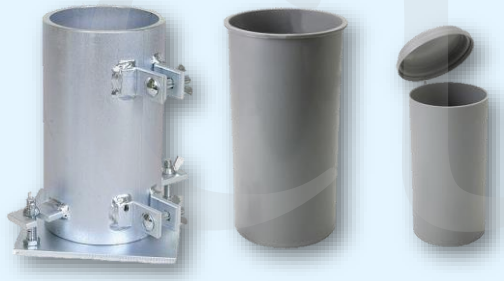
Molds

- Must be rigid and watertight
  - ~ A heavy grease or microcrystalline wax may be applied to the joints to prevent leakage
- May be reusable or single use
  - ~ Reusable molds shall be lightly coated before use with mineral oil or other nonreactive form release material

168

Apparatus

Cylinder Molds



Beam Molds

169

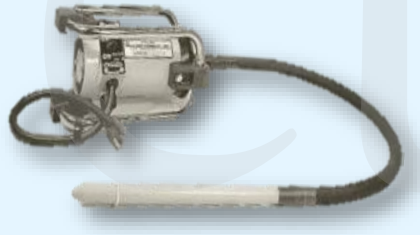
Apparatus

Tamping Rod

- 3/8 ± 1/16”
  - ~ < 6” cylinder diameter
  - ~ < 6” beam width
- 5/8 ± 1/16” steel
  - ~ ≥ 6” cylinder diameter
  - ~ ≥ 6” beam width
- 4” greater than the depth of mold but ≤ 24” in length
- Hemispherical tip(s)

170

Apparatus



Internal Vibrator

- ≥ 9000 vpm
  - ~ Check periodically with a vibrating – reed tachometer
- Vibrator element must be ≤ ¼ of the diameter of the cylinder mold or beam width
- Combined length of vibrator element and shaft ≥ 3” longer than depth of section being vibrated

171

Apparatus

Mallet

- **1.25 ± 0.50 lbs**
- **Rubber or Rawhide**

Float & Trowel

Placement Tools

- **Cylinders**
  - ~ **Scoop**
- **Beams**
  - ~ **Scoop or Shovel**

172

Place of Molding

Mold specimens as close as possible to the intended storage location

Mold specimens on a level, rigid surface

Surface should be free of vibration and other disturbances

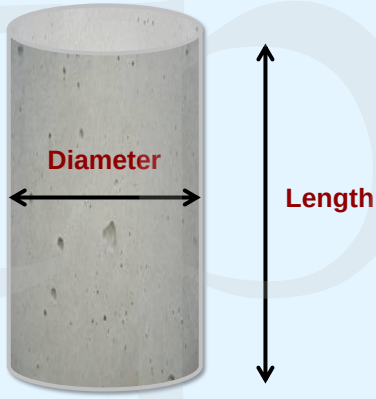
173

Cylinder Testing Requirements

Diameter
- **≥ 3 x NMAS**

Length
- **2 x Diameter**

Acceptance
- **6” x 12”**
- **4” x 8”**



174

Cylinders

The number and size of cylinders for acceptance testing is determined by the agency in charge

If NMAS > 2 inches, wet sieve over a 2 inch sieve

Method of consolidation is based on the slump

ASTM C 31 - Table 3

Slump	Method
≥ 1”	Rod or Vibrate
< 1”	Vibrate

175

4” Cylinders

Rodding

- 3/8” Rod
- 2 Lifts
- 25 Rods / Lift
  - ~ Penetrate previous lifts 1”
- Tap 10 – 15 times with the mallet after each lift is consolidated
  - ~ Use open hand on molds susceptible to permanent distortion by the mallet

Vibration

- 2 Lifts
- 1 Insertion / Lift
  - ~ Penetrate previous lifts 1”
- Tap at least 10 times with the mallet after consolidation of lift
  - ~ Use open hand on molds susceptible to permanent distortion by the mallet

176

6” Cylinders

Rodding

- 5/8” Dia. Rod
- 3 Lifts
- 25 Rods / Lift
  - ~ Penetrate previous lifts 1”
- Tap 10 – 15 times with the mallet after each lift is consolidated
  - ~ Use open hand on molds susceptible to permanent distortion by the mallet

Vibration

- 2 Lifts
- 2 Insertion / Lift
  - ~ Penetrate previous lifts 1”
- Tap at least 10 times with the mallet after consolidation of lift
  - ~ Use open hand on molds susceptible to permanent distortion by the mallet

177

Procedure
4” Mold - Rodding

Fill mold half full of concrete

- **Distribute concrete evenly across mold**

Rod bottom layer throughout the depth

- **Do not damage mold bottom**
- **Distribute rods uniformly**

178

Procedure
4” Mold - Rodding

Tap 10 – 15 times with mallet

- **Closes holes left by rodding**
- **Releases trapped air pockets**

179

Procedure
4” Mold - Rodding

Fill mold full

Rod top layer penetrating into bottom layer about 1”

- **Keep top layer above rim during consolidation**
  - ~ **Stop rodding and add concrete as necessary**
- **Distribute rods uniformly**

180

Procedure
4” Mold - Rodding

Tap mold 10 – 15 times using mallet

If mold is overfilled, remove excess concrete prior to strike-off

181

Cylinders

Finishing

Strike-off using tamping rod, float or trowel

- **Use the minimum manipulation necessary to produce a flat, even surface level with the rim of the mold**
- **No depressions or projections greater than 1/8”**

Cylinders may be capped with a thin layer of stiff portland cement paste

182

Cylinders

Marking

Identification

- **Mark specimens to identify the concrete it represents**
  - ~ **Do not alter top surface of concrete**
  - ~ **Do not mark removable caps**

183

Cylinders

Capping

Within 15 minutes of molding, move to initial place of curing

- **Level within ¼”/ft**
- **Lift and support single use molds from bottom**

Refinish top surface if marred or damaged in moving

Prevent moisture loss

- **Cover with cap**

184

Beam Testing Requirements

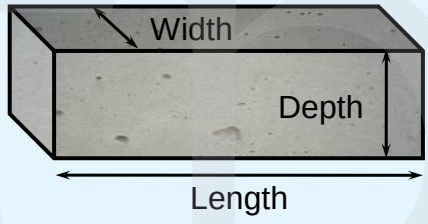
Ratio of Width to Depth

- $\frac{Width}{Depth} \leq 1.5$

Length

- **2” > 3 x depth**

Standard beam shall be 6 x 6 unless otherwise specified



Standard Beam
6” x 6” x 20”

185

Beams

The number and size of beams for acceptance testing is determined by the agency in charge

- **See Table 2 in ASTM C 31**

If NMAS > 2 inches, wet sieve over a 2 inch sieve

Method of consolidation is based on the slump

Table 3 – ASTM C 31

Slump	Method
≥ 1"	Rod or Vibrate
< 1"	Vibrate

186

Procedure
6" x 6" x 20" Beams

Fill the beam in the correct number of lifts

- **Rodding – 2 lifts**
- **Vibration – 1 lift**

When filling the final layer, avoid overfilling by more than ¼ inch

187

Procedure
6” x 6” x 20” Beams

Rodding

- 5/8” Rod
- 1 rod / 2 in.² of surface area
  - ~ 60 rods / lift (20” beam)
  - ~ Penetrate previous lifts about 1”
- Tap 10 – 15 times with the mallet after each lift is consolidated
- Spade each layer with trowel
  - ~ Sides and ends

188

Procedure
6” x 6” x 20” Beams

Spading

- Prevents honeycombing

Honeycombing

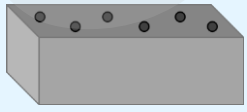
- Reduces flexural strength

189

6” x 6” x 20” Beams

Standard Beam

Wide Beam



Vibration

- Insert vibrator full depth
  - ~ Don’t touch mold with vibrator
- Insert at intervals ≤ 6” along centerline
  - ~ 3 - 4 insertions for a standard beam
  - ~ For beams wider than 6” use alternating insertions along two lines
- Tap mold at least 10 times with mallet after each lift is consolidated
- Do not spade

190

6” x 6” x 20” Beams

Finishing

Finish beams using a float or trowel

- Use the minimum manipulation necessary
- No depressions or projections greater than 1/8”

Within 15 minutes of molding, move to initial place of curing

- Level within ¼” per foot

Refinish surface if needed

Protect from moisture loss

- Plastic sheeting

191

Self Consolidating Concrete

Cylinders & Beams

- **Fill molds using procedure in ASTM C 1758**
  - ~ **Fill pouring vessel with SCC**
  - ~ **Fill mold with SCC by tilting pouring vessel**
    - ~ Lowest point on pouring vessel rim shall be ≤ 5 inches above top of mold
    - ~ Evenly distribute the SCC without rodding or tapping sides of mold
- **Finish without further consolidation**

192

Curing

Curing is maintaining the moisture and temperature conditions required for proper hydration of the concrete mixture.

Proper curing allows the concrete to develop to its full potential.

Standard Curing

- **Acceptance testing for specified strength**
- **Checking adequacy of mixture proportions**
- **Quality control**

Field Curing

- **Determining when a structure may be put into service**
- **Form removal time**
- **Checking adequacy of curing and protection of structure**
- **Comparison tests**

193

Standard Curing

Most specifications assume standard curing

Checks the concrete that was delivered to the jobsite and placed in the structure

- **This is normally what determines if:**
  - **Someone gets paid for the concrete or not**
  - **The concrete can remain in place or if it needs to be removed**

Does not check the outside influences of temperature, moisture, and protection

194

Standard Curing

Initial curing is the time period in which the fresh concrete "sets" and becomes rigid.

Initial Curing Conditions

- **Time Period**
  - **Up to 48 hours after molding**
- **Temperature**
  - **F'c < 6000 psi**
    - 60° – 80°F
  - **F'c ≥ 6000 psi**
    - 68° – 78°F
- **Prevent moisture loss**
- **Shield specimens from direct sunlight or heat**
- **Record minimum and maximum temperatures for each set**

195

Standard Curing

Controlling Moisture

- Cover with removable plastic lids
- Store in properly constructed boxes

Controlling Temperature

- Thermostatically controlled heating and cooling devices
- Light bulbs
- Fans
- Water baths
- Ice

196

Transporting Specimens

Specimens shall not be transported until at least 8 hours after final set

Protect specimens during transport from:

- Jarring
- Freezing
- Moisture loss

Transportation time allowed

- No more than 4 hours

197

Standard Curing

Final curing is the time period in which the fresh concrete begins to gain strength.

Remove Molds

- **Transfer identification markings**
- **Final curing must begin within 30 minutes of mold removal**

Final Curing

- **Maintain free water on surfaces**
  - ~ **Moist rooms**
    - ~ Prevent drips and contact with flowing water
  - ~ **Storage tanks**
- **Temperature**
  - ~ **73.5 ± 3.5 °F**

198

Standard Curing

Moist Room

Water Tank

199

Water Tanks
ASTM C 511

Water tanks must be saturated with calcium hydroxide

- **High-calcium hydrated lime**

Water tanks must be stirred every month to replace depleted calcium ions

- **Clean and refill tanks every 2 years**
  - **3g of calcium hydroxide per liter of water**
  - **1 gal = 3.785412 liters**

This slide is for information only !

200

Standard Curing

Beams

- **Beams are cured the same as cylinders except that storage shall be in water saturated with calcium hydroxide for at least 20 hours prior to testing**
  - **Prevent surface drying between removal from water and the completion of testing**
    - Small amounts of drying may significantly reduce the flexural strength

201

Field Curing

Field curing approximates what is happening to the structure itself.

Specimens are treated like the structure.

Cylinders

- **Store near the point of deposit**
- **Protect like the formed concrete**
  - ~ **Provide like temperature and moisture conditions**
    - ~ Includes transport
- **Remove cylinders from molds when formwork is removed**

Testing

- **Remove from field**
  - ~ **Maintain moisture and test in "as is" condition**

202

Field Curing

203

Field Curing

Beams

- **Cure in the same manner as structure**
- **Remove from molds within 48 ± 4 hours**
  - **Slabs**
    - Store on ground with top surfaces up
    - Bank ends and sides with damp earth or sand
  - **Structures**
    - Protect in same manner as structure
- **Testing**
  - **Remove from field and store in water saturated with calcium hydroxide for 24 ± 4 hours prior to testing**

204

Report

Identification number

Location of concrete placement

Date, time, and name of individual who molded specimens

Test Results

- **Slump, air content, and temperature**
- **Method Deviations**

Curing Method

205

Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 173
AASHTO T 196

cttp
Center for Training Transportation Professionals

208

Scope

This method may be used to determine the air content of freshly mixed concrete containing any type of aggregate

- **Dense**
- **Cellular**
- **Lightweight**

Measures the air contained in the mortar fraction of the concrete and is not affected by the air trapped inside porous aggregates

209

Apparatus

Volumeter

- **Metal or plastic**
- **Bowl**
  - ~ **Dia.= 1 to 1.25 x Height**
  - ~ **Volume ≥ 0.075 ft³**
- **Top Section**
  - ~ **Volume ≥ 1.2 x Vol. of Bowl**
- **Clamp**
- **Cap**

210

Apparatus

Watertight Cap

Numbers get larger as you go down the neck!

Graduations must be in at least 0.5 % increments and cover a range of 0 to 9 % of bowl volume

Rubber gasket in top section flange

A watertight seal must be formed when top section is attached to bowl

211

Apparatus

Tamping Rod

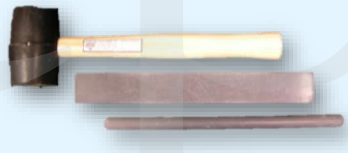
- Steel or polyethylene
  - ~ 5/8" ± 1/16" dia.
  - ~ 4" > mold depth but ≤ 24" in length
  - ~ Hemispherical tip

Mallet

- Rubber or rawhide
  - ~ 1.25 ± 0.5 lb

Strike-Off Bar

- Steel
  - ~ ≥ 1/8" x ¾" x 12"
- Polyethylene
  - ~ ≥ ¼" x ¾" x 12"



212

Apparatus

Pouring Vessel

1 pint = 2 cups

Syringe

Calibrated Cup

Used to add water when air content is > 9 %

Funnel

213

Apparatus

Alcohol is added during the <u>initial</u> filling of the meter with water

- **Dispels the foam that collects in the neck during testing**

Isopropyl Alcohol 70% by Volume

214

Calibration

Required

- **Initially**
- **Annually**
- **Whenever there is a question of accuracy**

Calibrated Cup

- **Volume at 70°F**
  - ~ **1.00 ± 0.04 % of bowl volume**

Volumeter

- **Bowl**
  - ~ **Volume**
  - ~ **≥ 0.075 ft³**
- **Top Section**
  - ~ **Graduations**
  - ~ **≤ 0.1 % Error**

215

Procedure

Preparation

- **If aggregate is retained on a 1.5 inch sieve, wet sieve over a 1 inch sieve**

Dampen the inside of the bowl and remove any standing water from the bottom

216

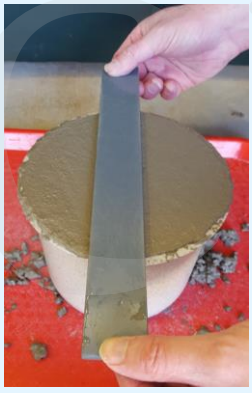
Procedure

Fill the bowl in two layers

- **Rod each layer 25 strokes**
  - ~ **Penetrate previous layer 1”**
- **Tap bowl with mallet**
  - ~ **10 –15 times each layer**

217

Procedure



Add or remove concrete to obtain approximately 1/8” excess concrete above the rim

Strike off surface flush with top of bowl using strike-off bar

Clean bowl flange completely

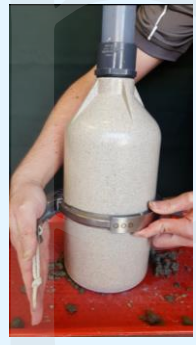
218

Procedure

Wet the inside of the top section and gasket

- **Clean clamp**

Attach top section to bowl



219

Procedure

Insert funnel

Add <u>at least</u> one pint of water

1 pint = 2 cups

220

Procedure

Add the selected amount of alcohol

- **Record # of pints of alcohol used**

Adding alcohol to dispel foam after the initial filling of meter is <u>not</u> permitted

221

Procedure

Continue to add water until the water level appears in the neck

222

Procedure

Remove funnel and adjust water level so that the bottom of the meniscus is at the zero mark on neck

- **Rubber syringe**

Secure cap

- **Check for leaks**

223

Procedure

Free Concrete from Base

- **Invert meter**
  - ~ **Shake horizontally**
  - ~ **No more than 5 seconds at a time**
- **Return meter to an upright position**

224

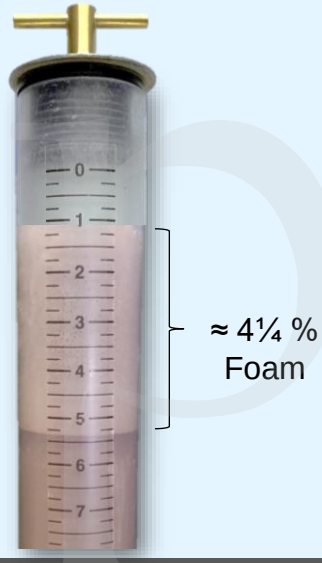
Procedure

Repeat process for a minimum of 45 seconds

- **Aggregate should be heard moving in the meter**
- **Dislodge trapped aggregate in the neck**

Check foam level

- **Desired foam is less than 2 %**
- **Invert additional times if needed**



225

Procedure

Rolling

- Tilt meter to 45°
- Vigorously roll the meter ¼ to ½ turn back and forth
- Rotate base 1/3 turn
- Continue rolling and turning for approximately 1 minute
  - ~ Aggregate must be heard sliding in the base

226

Procedure

Stabilization

- Stand meter upright
- Remove the cap

All readings are taken with the top off !

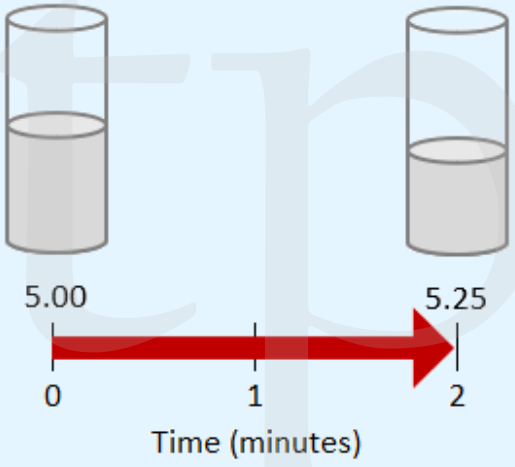
227

Procedure

Stabilization

- **Read liquid level**
- **Wait two minutes**
- **Read liquid level again**

Level is <u>stable</u> when the reading changes by 0.25 % or less over 2 minutes

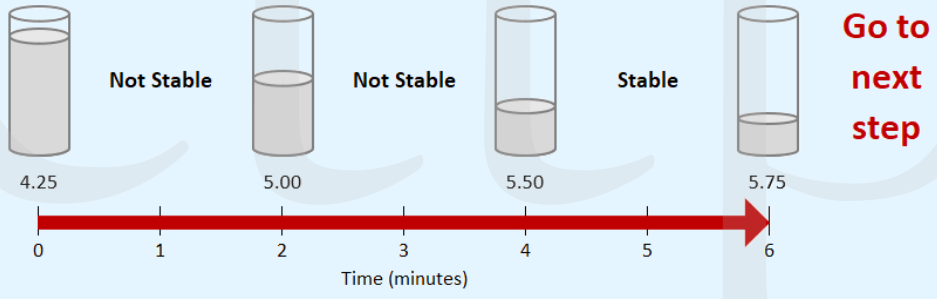


228

Procedure

Stabilization period after each rolling:

- **6 minute maximum (use only what time is needed)**

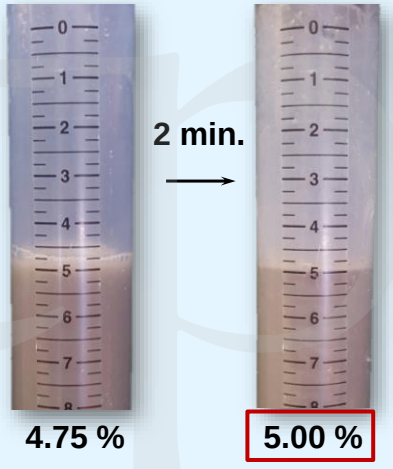


229

Procedure

After 1st Rolling

- **Stable**
  - ~ **Check foam**
    - ~ If foam is greater than 2%, discard the test and start a new test using more alcohol
  - ~ **Record last reading as the "Initial" meter reading**
- **Not Stable**
  - ~ **If not stable within 6 minutes, discard the test and start a new test using more alcohol**



230

Procedure

Roll meter for another minute

- **2nd rolling**

Stand meter upright

Remove cap

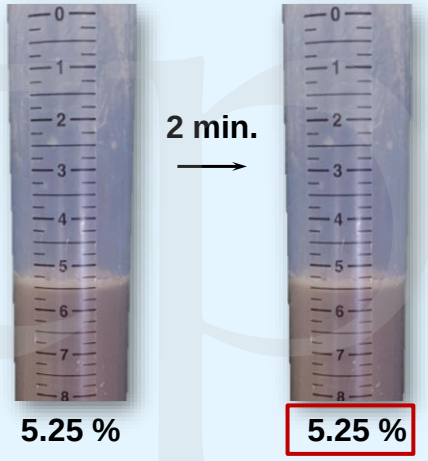
Repeat stabilization procedure

231

Procedure

After 2nd Rolling

- **Stable**
  - ~ **Record last reading as the "Final" meter reading**
- **Not Stable**
  - ~ **If not stable within 6 minutes, discard the test and start a new test using more alcohol**



232

Procedure

Compare readings

Readings within 0.25 %

- **Determine reported air content**

Readings not within 0.25 %

- **Repeat rolling and stabilization procedure for 3rd time**
- **Replace "Initial" reading value with "Final" reading value**
- **Record new "Final" reading**

Initial meter reading	5.00
Final meter reading	5.25
Alcohol content correction	
Calibrated cups of water added	
Reported air content	
The test is (select one)	valid / invalid

233

Procedure

If the new "Final" meter reading is > 0.25 % different from the new "Initial" meter reading:

- **Start a new test using more alcohol**

When a "Final" meter reading is recorded and is within 0.25 % of the recorded "Initial" meter reading, determine the reported air content to the nearest 0.25 %

Determine if the test is valid or invalid

234

Procedure

Valid / Invalid

- **Disassemble the meter**
- **Dump the base**

Examine base for undisturbed, tightly packed concrete

- **Valid – no concrete paste**
- **Invalid – undisturbed packed concrete**

235

Procedure

Valid Test

Invalid Test

236

Calculation

Report air content to the nearest 0.25 %

A	**Air content (%)**
A_R	**Final Meter Reading (%)**
C	**Alcohol Correction Factor**
W	**# of Calibrated Cups of Water Added**

$$A = A_R - C + W$$

237

Calculation

Alcohol Correction (Table 1 – ASTM C 173)

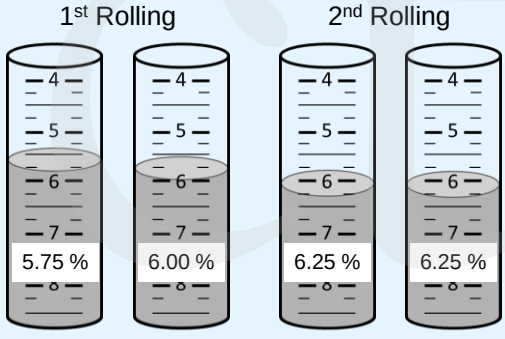
- **If 2.5 pints or more of alcohol were added, a correction to the final meter reading is required**

Pints of Alcohol	Correction
≤ 2.0	0.00
3.0	0.25
4.0	0.50
5.0	0.75

238

Air Content Calculation

2 Pints Alcohol

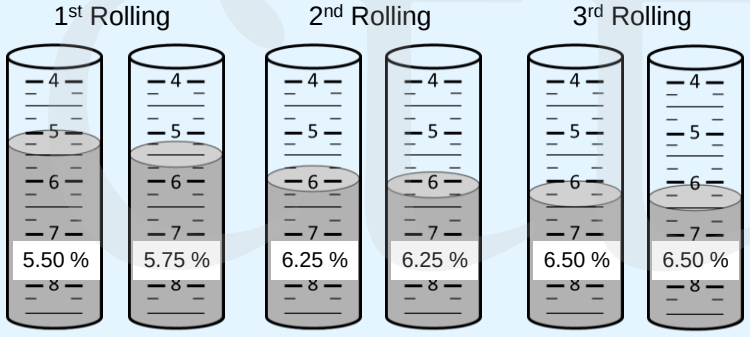


Initial meter reading	6.00
Final meter reading	6.25
Alcohol correction factor	0
Calibrated cups of water added	0
Reported air content	**6.25**

239

Air Content Calculation

3 Pints Alcohol



Initial meter reading	6.25
Final meter reading	6.00
Alcohol correction factor	0.25
Calibrated cups of water added	0
Reported air content	6.25

240

Calculation

What if after rolling (1st time), the air content is greater than 9%?

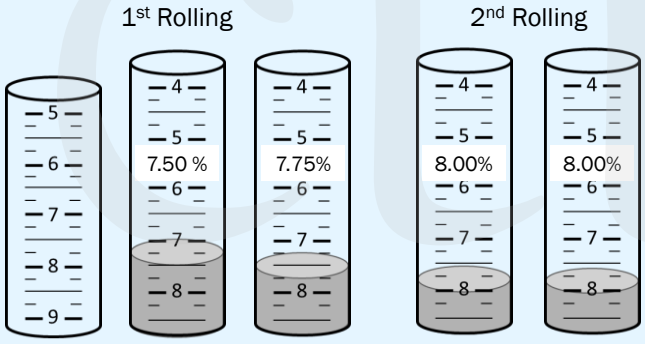
- **Add calibrated cups of water until the water level appears in the neck**
- **Read the bottom of the meniscus to nearest 0.25 %**
- **Record the # of calibrated cups of water added**
- **Complete all steps of test**

241

Air Content Calculation

4 Pints Alcohol

3 Calibrated Cups of Water



Initial meter reading	7.75
Final meter reading	8.00
Alcohol correction factor	0.50
Calibrated cups of water added	3
Reported air content	**10.50**

242