Fresh Concrete: Sampling and Testing

Understanding ASTM International Test Procedures for Cement and Concrete - Staying Up to Standard

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Overview

Fresh Concrete Sampling and Testing

- ***ASTM C172 – Sampling Freshly Mixed Concrete***
- ASTM C31 – Making and Curing Concrete Test Specimens
- ASTM C143 – Slump of Concrete
- ASTM C138 – Density (Unit Weight), Yield, and Air Content
- ASTM C403 – Time of Setting Concrete
- ASTM C232 – Bleeding of Concrete

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Scope

- This practice addresses procedures for obtaining a representative sample of fresh concrete in the field.
- This practice also addresses procedures for removing aggregate, larger than a designated size, from the sampled concrete.
  - this procedure is known as wet sieving

General Requirements: Sampling

- The time between obtaining the first and final portions of the composite sample shall not exceed 15 min.
- After obtaining the necessary portions, transport the material to the location where tests are to be conducted or specimens are to be molded.

If wet sieving is necessary, it is performed at this point in the sampling process.

General Requirements: Sampling

- Combine and mix the portions,
  - use a shovel
  - mix the minimum amount necessary to achieve uniformity
  - do not exceed any time limitations

After the portions of the sample are combined, the concrete is then referred to as a composite sample.

General Requirements: Sampling

- Be expeditious (quick) in obtaining and using the sampled concrete.
- Protect the sample from,
  - sun
  - wind
  - rapid evaporation
  - contamination

General Requirements: Sampling

- Start tests for slump, temperature, and air content (pressure or volumetric) within 5 min. after obtaining the final portion of the composite sample.
- Start molding strength specimens (cylinders or beams) within 15 min. after fabricating the composite sample.

General Requirements: Sample Size

- A minimum of 28 L of material is needed when strength specimens are to be molded.
  - smaller sized samples are permitted for routine temperature, slump and air content tests
- Sample sizes shall be based on the maximum aggregate size.
- Sampling procedures shall be such that a representative sample is obtained.

Procedure: Stationary Mixer

Sampling from stationary mixers, except paving mixers.

- These sampling requirements apply to tilting and non-tilting mixers.
- Obtain 2 or more portions at regular intervals from the middle portion of the batch.
- Note 3 - Do not obtain material before 10% or after 90% of the batch has been discharged.

Procedure: Stationary Mixer

- Sample either by,
  - passing a receptacle completely through the discharge stream
  - completely diverting the discharge into a container
- If necessary, discharge the entire batch of concrete into a receptacle before obtaining a sample as described above.
  - the receptacle must accommodate the entire batch

Procedure: Stationary Mixer

- Do not restrict the flow of the concrete, or otherwise cause segregation.
- Combine all portions into a single sample for testing.

Procedure: Paving Mixer

Sampling from paving mixers.

- Sample the concrete after the contents of the mixer have been discharged.
- Obtain material from at least 5 different portions of the pile of discharged concrete.
- Avoid contamination, or prolonged contact, of the concrete with the subgrade.

Procedure: Paving Mixer

- As an alternative to taking samples from the discharge pile,
  - place three shallow containers on the subgrade
  - discharge the concrete into the containers
- Combine all portions into a single sample for testing.

Procedure: Revolving Drum Mixer

Sampling from revolving drum mixers or agitators.

- Obtain 2 or more portions at regular intervals from the middle portion of the batch.
- Do not obtain any material until all water and any admixtures have been added to the mixer.
- Note 3 - Do not obtain material before 10% or after 90% of the batch has been discharged.

Procedure: Revolving Drum Mixer

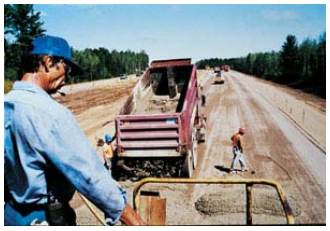
- Sample either by,
  - repeatedly pass a receptacle through the entire discharge stream
  - completely diverting the discharge into a container
- Control the rate of discharge by controlling the rate of revolution of the drum.
- Combine all portions into a single sample for testing.

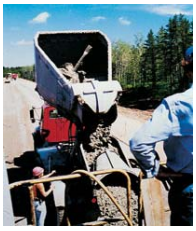
Procedure

Procedure: Other Units

Sampling from open-top truck mixers, agitators, non-agitating equipment, or other types of open-top containers.

- Take samples by the most applicable procedure from those previously described.

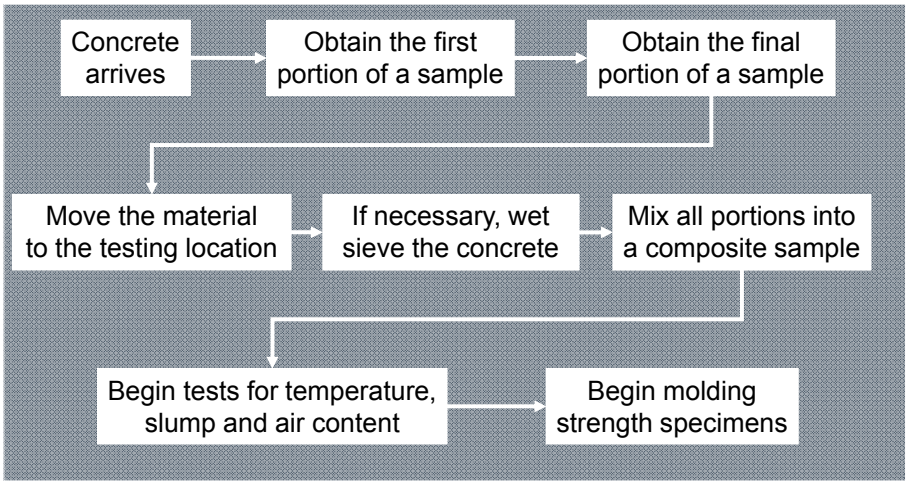




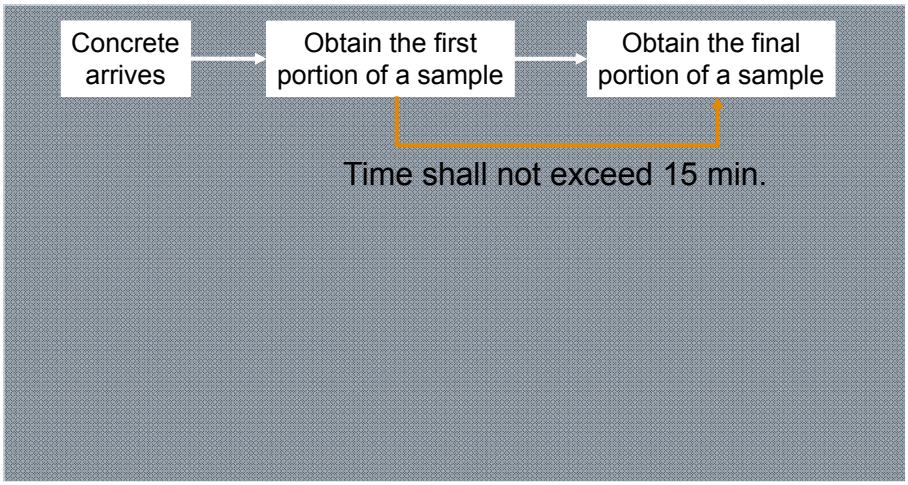
Sampling Time Line

- The following slides present a summary time line with respect to sampling and testing concrete in the field.
  - this time line is based on concrete being delivered to a project site by means of a revolving drum truck mixer

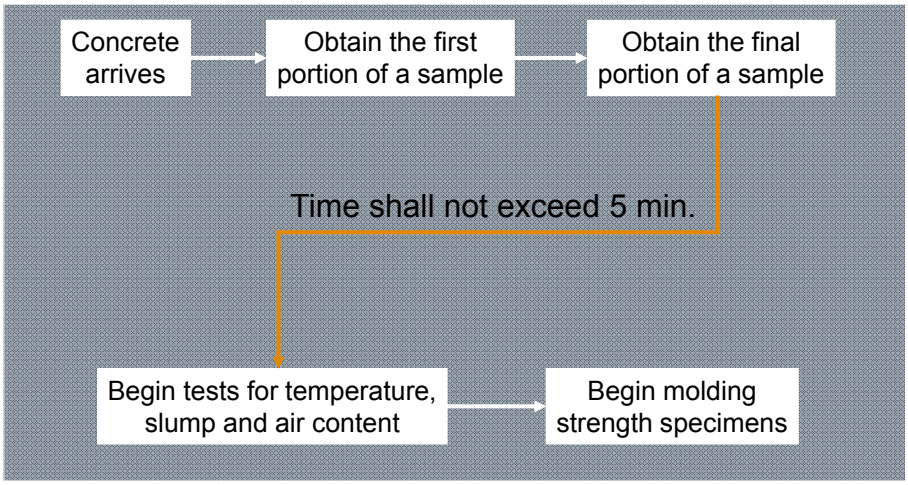
Sampling Time Line



Sampling Time Line



Sampling Time Line



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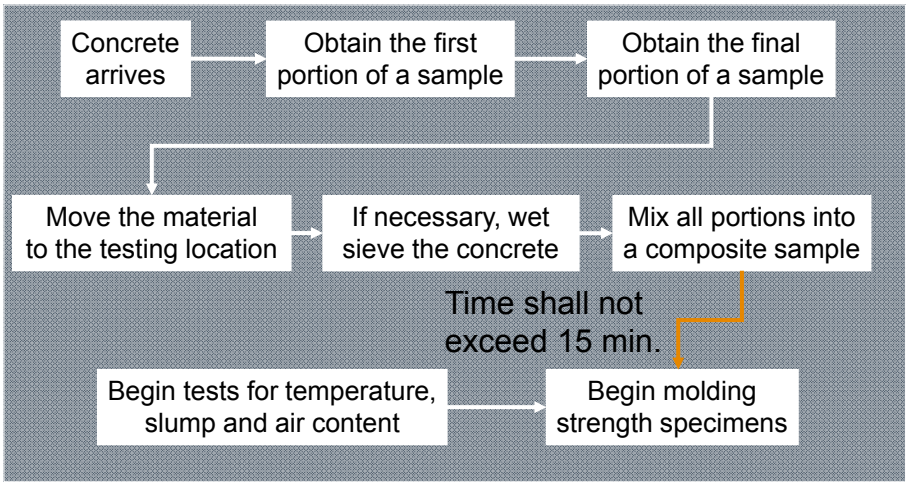
Sampling Time Line



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Limitations

- Elapsed time between obtaining the first and last portions of the composite sample is 15 minutes.
- Tests for slump or air content must begin within 5 minutes after obtaining the final portion of the composite sample.
- Molding strength specimens must begin within 15 minutes after making the composite sample.

Overview

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Scope/Significance and Use

- ***Scope:*** This practice covers procedures for making and curing cylinder ~~and beam~~ specimens from representative samples of fresh concrete for a construction project.
- ***Significance and Use:*** This practice provides standardized requirements for making, curing, protecting, and transporting concrete test specimens under field conditions.

Use of Results: Curing

If specimens are made for:

- **Standard Cure:**
  - Acceptance testing for specified strength,
  - Checking adequacy of mixture proportions, or
  - Quality control.
- **Field Cure:**
  - Determination of whether a structure is capable of being put in service,
  - Comparison of test results to standard cured or test results form different in-lace tests,
  - Adequacy of curing and protection, or
  - Form or shoring removal time requirements.

Apparatus: Consolidation

- Tamping rod
  - 10 mm diameter for 150 mm specimens
  - 16 mm diameter for 150 mm and larger specimens
  - **Rounded tip (to same diameter as rod)**
- Vibrator
  - Internal vibrator with a frequency of 150 hz.
  - Diameter ≤ ¼ diameter of cylinder

TABLE 1 Tamping Rod Diameter Requirements

Diameter of Cylinder or Width of Beam mm [in.]	Diameter or Rod mm [in.]
<150 [6]	10 ± 2 [⅜ ± 1/16]
≥150 [6]	16 ± 2 [⅝ ± 1/16]

Apparatus: Placement and Finishing

- Placement
  - Scoops for cylinders
  - Scoops or shovels for beams
  - Large enough for a representative sample but small enough to avoid spilling
- Finishing
  - Handheld float or trowel

Apparatus: Sampling and Fresh Properties

- Sampling
  - Large pan, wheel barrow, or flat (clean and non-absorbant) board large enough for remixing the material with a trowel or shovel
- Slump – ASTM C143
- Air Content – ASTM C173 or C231
- Temperature – ASTM C1064

Test Requirements – Cylinders

- Shall be cast and allowed to set in an upright position.
- Mold Diameter ≥ (3 x NMS)
  - NMS = Nominal Maximum Size of the coarse aggregate
- Mold Height = (2 x Diameter)

Test Requirements – Cylinders

- For acceptance testing, molds can be either
  - 150 x 300 mm

  or
  - 100 x 200 mm size.

Test Requirements – Cylinders

- When the NMS of the coarse aggregate is greater than 50 mm, wet sieve the concrete over a 50 mm sieve.
- The specifier of the tests shall establish the number and size of the specimens to be cast.

Test Requirements – Cylinders

- Based on the mold diameter and wet sieving requirements, the following can be inferred from the standard
  - **100 mm diameter cylinders** can be used only when the NMS of the coarse aggregate is **≤30 mm**
  - **150 mm diameter cylinders** can be used when the NMS of the coarse aggregate is **≤ 50** mm or when the concrete is wet sieved over a 50 mm sieve

Casting Cylinders: Method of Consolidation

- Determine method of Consolidation from Table 3

TABLE 3 Method of Consolidation Requirements

Slump, mm [in.]	Method of Consolidation
≥25 [1]	rodding or vibration
< 25 [1]	vibration

- Depending on the method of consolidation, determine the molding requirements from Table 4 or Table 5.

Molding Requirements

- For 100 mm diameter cylinders:

Rodding	Vibration
10 mm rod	≤ 25 mm shaft
2 layers	2 layers
25 roddings per layer	1 insertions per layer

Molding Requirements

- For 150 mm diameter cylinders:

Rodding	Vibration
16 mm rod	≤ 38 mm shaft
3 layers	2 layers
25 roddings per layer	3 insertions per layer

Casting Cylinders

- Use a scoop to place concrete in the mold.
- Move the scoop around the mold opening so material is evenly distributed and segregation is minimized.
- When placing the final layer, add enough concrete so that the mold is full after consolidation.
- Consolidate each layer of concrete.

Rodding - Cylinders

- Fill molds in layers of approximately equal volume.
- Rod each layer 25 times.
  - uniformly distribute the rodding strokes over the cross section of the mold
  - rod the bottom layer through its depth
  - rod each upper layer through its depth and into the layer below approximately 25 mm

Procedure: Making Cylinder Specimens

Standard Curing Procedure

- Initial Curing:
  - Immediately after molding and finishing,
  - Specimens shall be store for up to 48 hrs between 16-27°C and preventing moisture loss.
  - Note: For mixture with specified strength ≥40 MPa initial curing temperature between 20-26°C
- Final Curing
  - Within 30 minutes of removal from the mold cure specimens with free water on the surface at all times and at a temperature of 23±3°C in water storage tanks or moist room (complying with ASTM C511) except when preparing specimens for testing.

Standard Curing Procedure - Final Curing (Cont.)

- Standard curing temperatures are not required,
  - for up to 3 hrs immediately prior to testing
  - if free moisture is maintained on the cylinders
  - if the ambient temperature remains between 20 and 30 °C
- When capping with sulfur mortar, dry the ends of the specimen to prevent the formation of steam or foam pockets.

Field Curing Procedure

- Store cylinders in or near the structure as near location where concrete was deposited.
- Test specimens in the moisture condition that results from the specimen being cured in the field.
- Specimens made for determining when a structure can be put in service shall be removed from their molds when formwork is removed from the structure.

Cement & Concrete Testing Workshop Part II: Presentation Overview

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Scope

- This test method addresses the procedures for determining the slump of hydraulic-cement concrete.
- The slump test can be conducted both in the field and laboratory.

Summary of Test Method

- A sample of concrete is placed in a mold and consolidated.
- The mold is then raised vertically and the concrete is allowed to settle.
- Slump is the vertical distance between the original and displaced center of the concrete surface.

Significance and Use

- This test is considered applicable to concrete having coarse aggregate up to 37.5 mm in size.

Significance and Use

- When the aggregate is larger than 37.5 mm,
  - wet sieve the concrete over a 37.5 mm sieve
  - test the sieved material

Note that the standard does not state whether the aggregate size is an absolute maximum or nominal maximum.

Significance and Use

- This test is NOT applicable to non-plastic, non-cohesive concrete.
  - non -plastic concrete is defined as having a slump less than 15 mm
  - non-cohesive concrete is defined as having a slump greater than about 230 mm

Significance and Use: Note 1

- The slump test was originally devised to provide a method to monitor the consistency of unhardened concrete.
- Under field conditions a relationship between slump and strength cannot be clearly and consistently shown.

Apparatus

- Mold
- Tamping Rod
- Measuring Device
- Scoop

Apparatus: Mold

- May be metal or an alternate material.

Apparatus: Mold

- Shall be in the shape of the frustum of a cone.
  - 100 mm wide top, 200 mm wide base, 300 mm height
- Dimensions shall be checked and recorded,
  - when purchased or first used
  - at least annually
- Shall have foot fins and handles.

Apparatus: Alternate Material Molds

- Non-metal molds are permissible if they,
  - meet the shape and dimensional requirements of metal molds
  - are rigid, dimensionally stable, resistant to impact, and non-absorbent
  - provide results comparable to metal molds
- Initial comparability tests are the responsibility of the manufacturer.

Apparatus: Alternate Material Molds

- If the condition of a mold is suspected of being out of tolerance from the as manufactured condition,
  - perform a single comparative test with a metal mold
  - the difference in measured slump between the metal and alternate material mold may not be more than 15 mm
  - molds that fail the test shall be removed from service

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Apparatus: Alternate Material Molds

Apparatus: Tamping Rod

- Round, smooth, straight, steel.
- 16 mm diameter.
- Tamping end, or both ends, shall be rounded to a hemispherical tip.

Apparatus: Tamping Rod

- The length shall be at least 100 mm greater than the depth of the mold, but not greater than 600 mm.
  - a length of 400 to 600 mm meets these requirements

Apparatus: Measuring Device

- Ruler, roll-up tape, or similar device.
- Rigid or semi-rigid.
- Marked with increments of 5 mm or smaller.
- Minimum length of 300 mm.

Apparatus: Scoop

- Shall have a size,
  - large enough so the material taken from the sampling receptacle is representative
  - small enough so concrete is not spilled during placement of material in the mold

Procedure: Sample

- Obtain a representative sample of concrete according to ASTM Practice C 172.

Procedure: Dampen Mold

- Dampen the mold and place on a rigid, flat, level, moist, and non-absorbent surface that is free of vibration.

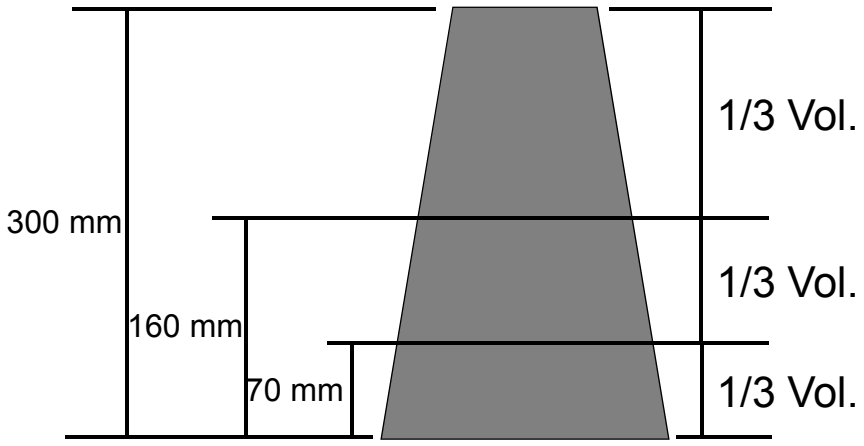
Procedure: Secure Base

- Stand on the two foot fins while filling the mold and cleaning the perimeter.
  - clamping the mold to a base is also permitted

Procedure: Filling Mold

- Use a scoop to place concrete in the mold.
- Move the scoop around the mold opening so material is evenly distributed and segregation is minimized.
- Fill the mold in three layers of approximately equal volume.
  - fill the mold to 70 mm, 160 mm, and then 300 mm from the base

Procedure: Filling Mold



Procedure: Rodding Concrete

- Rod each layer 25 times.
  - uniformly distribute the rodding strokes over the cross section of a layer
  - rod the bottom layer through its depth
  - rod each upper layer through its depth and into the layer below approximately 25 mm

Procedure: Rodding Concrete

- While rodding the bottom layer,
  - slightly incline the rod
  - rod around the mold perimeter using about half of the 25 strokes
  - conclude with vertical strokes near the center of the mold
- For the top layer,
  - heap concrete above the mold prior to rodding
  - add concrete as necessary to keep an excess above the top of the mold at all times

Procedure: Strike-off Concrete

- Strike-off the mold with the tamping rod in a screeding and rolling motion.

Procedure: Raising the Mold

- Holding the mold down firmly, clear away any concrete from the area surrounding the base.
  - prevent interference with the slumping concrete
- Remove the mold immediately after clearing the base of concrete.
- Raise the mold vertically in 5 ± 2 seconds.
  - there should be no lateral or torsional (twisting) motion

Procedure: Timing Requirements

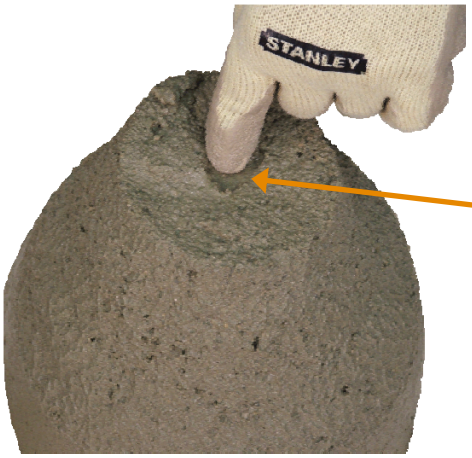
- Complete the entire test without interruption, from the start of filling to removal of the mold, within 2½ minutes.

Procedure: Measuring Slump

- When measuring the slump,
  - measure immediately after removing the mold
  - measure the vertical difference between the top of the mold and the displaced original center
  - if a falling away or shearing occurs, disregard the test and make a new test using another portion of the sample

To measure slump, it is convenient to invert the mold and place it next to the slumped concrete.

Procedure: Measurement Location



Displaced
Original
Center

Procedure: Measurement Procedure

Procedure: Measurement Procedure

Report

- Slump is reported to the nearest 5 mm.

Limitations and Errors

- Slump test is suitable for slumps of medium workability, slump in the range of 15 – 230 mm.
- Test fails to determine the difference in workability in stiff mixes which have zero slump, or for wet mixes that give a collapse slump.
- Limited to concrete formed of aggregates of less than 37.5 mm
- Lacks to tell you anything about water content, w/c, w/cm, strength, air, shrinkage, pump-ability, response to the vibrator and slip forms, and finishability.
- User dependent.
- Very sensitive to time from mixing and time in cone.

Factors Affecting Slump

1. Content, proportions, chemistry, fineness, particle size distribution, moisture content and temperature of cementitious;
2. Content, proportions, size, texture, combined grading, cleanliness and moisture content of the aggregates;
3. Dosage, type, combination, interaction, sequence of addition, effectiveness of chemical admixtures;
4. Air content;
5. Batching, mixing and delivery methods and equipment;
6. Temperature of the concrete;
7. Sampling, slump-testing technique and the condition of test equipment;
8. The amount of free water in the concrete; and
9. Time since batching at the time of testing.

Slump is Influenced by Everything!

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Scope

- This test method addresses the procedures for determining the density and calculating the yield, cement content, and air content of fresh concrete.

Terminology

- ***Density:*** mass per unit volume of concrete, kg/m^3
- ***Yield:*** volume of concrete produced for a batch, m^3
- ***Gravimetric Air Content:*** air content computed as a percentage of the volume of concrete and determined on the basis of a theoretical and measured density, %

Terminology

- ***Theoretical Density:*** density of the concrete computed on an air free basis, kg/m^3.
  - density computed based on the mass and volume of the liquids and solids only
  - volume occupied by air (both entrapped and entrained) is taken as zero
  - T = M / V
  - M = Σ M = Σ [all masses]
  - V = Σ V = Σ [Mass / (1000*Specific Gravity)]

Apparatus

- Balance (scale)
- Tamping rod
- Internal Vibrator
- Measure
- Strike-off Plate
- Mallet
- Scoop

Apparatus: Balance

- Accurate, at any point in the range of use, to the greater of,
  - 45 g or
  - 0.3% of the load in the range of use
- "Range of use" extends from the mass of the measure when empty to the mass of the measure filled with material having a density of 2600 kg/m^3.

Apparatus: Tamping Rod

- Round, smooth, straight, steel.
- 16 mm diameter.
- Tamping end, or both ends, shall be rounded to a hemispherical tip.
- The length shall be at least 100 mm greater than the depth of the measure, but not greater than 600 mm.
  - a length of 400 to 600 mm meets these requirements

Apparatus: Internal Vibrator

- Rigid or flexible shaft.
- Preferably powered by an electric motor.
- Frequency ≥ 7000 vibrations/min.
- 19 mm ≤ diameter, or side dimension ≥ 38 mm

Apparatus: Measure

- Cylindrical container.
- Minimum capacity based on the Nominal Maximum Size (NMS) of the coarse aggregate per Table 1.
- Shall conform to the requirements of ASTM C29.

Apparatus: Table 1

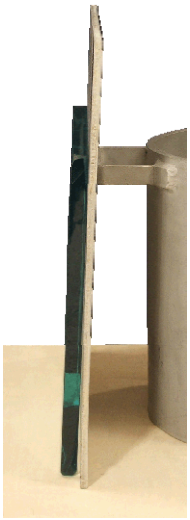
NMS of Coarse Aggregate (mm)	Capacity of Measure (L)
25.0	6
37.5	11
50	14
75	28
112	70
150	100

Apparatus: Measure

- When an air meter bowl is used as the measure,
  - the bowl shall conform to the requirements of ASTM C231
  - the bowl shall be calibrated for volume per ASTM C29
  - the top rim shall be smooth and plane within 0.3 mm.

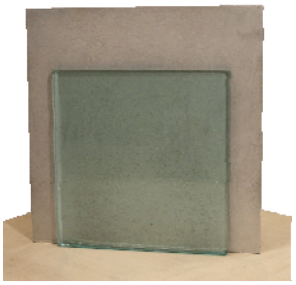
Apparatus: Strike-off Plate

- Flat, rectangular plate.
- Can be made of,
  - metal, 6 mm thick
  - glass or acrylic, 12 mm thick



Apparatus: Strike-off Plate

- Length and width should be at least 50 mm greater than the diameter of the measure.
- Edges shall be straight and smooth within 2 mm.



Apparatus: Mallet

- Shall have a rubber or rawhide head.
- Required mass of head depends on the capacity of the measure.
  - 600 ± 200 g, for measures ≤ 14 L
  - 1000 ± 200 g, for measures > 14 L

Apparatus: Scoop

- Shall have a size,
  - large enough so the material taken from the sampling receptacle is representative
  - small enough so concrete is not spilled during placement of material in the mold

Procedure: Note

To compute density, it is necessary to determine the mass and volume of the empty measure.

follow the procedures in Section 8 of ASTM C 29 to determine the volume of any measure

Procedure: Sample

- Obtain a representative sample of concrete according to ASTM Practice C172.

Procedure

- Unless otherwise specified, determine the method of consolidation based on the measured slump.

Measured Slump	Method of Consolidation
Slump < 25 mm	Vibrate
25 mm < Slump < 75 mm	Rod or Vibrate
Slump ≥ 75 mm	Rod

Procedure

- Dampen the interior of the measure. Place measure on a flat, level, and firm surface.
- Use a scoop to place concrete in the measure.
- Move the scoop around the measure opening so material is evenly distributed and segregation is minimized.

Procedure: Rodding

- Fill the measure in three layers of approximately equal volume.
- Consolidate the concrete using the rounded end of the tamping rod.
  - uniformly distribute the rodding strokes over the cross section of the measure
  - rod the bottom layer through its depth
  - rod each upper layer through its depth and into the layer below approximately 25 mm.

Procedure: Rodding

- Number of rodding strokes per layer is a function of the size of the measure.

Volume of Measure	Number of Strokes per Layer
Volume ≤ 14 L	25
Volume = 28 L	50
Volume > 28 L	1 per each 20 cm^2 of surface area

Procedure: Rodding

- After rodding a layer, tap the outside of the measure 10 to 15 times with a mallet.
  - This closes voids left by the rod and releases large air bubbles
- Avoid overfilling the measure when adding the final layer of concrete.

Procedure: Vibration

- Fill the measure in two approximately equal layers.
- Add all material for a layer before vibrating the layer.
- With each layer, insert the vibrator at three different points.
- For the final layer, the vibrator shall penetrate the layer below approximately 25 mm.

Procedure: Vibration

- Do not allow the vibrator to touch the measure.
- Withdraw the vibrator so that no air pockets are left in the concrete.
- Continue vibrating until proper consolidation is achieved.
  - duration will depend on the characteristics of the concrete and vibrator
  - duration should be consistent for all insertions

Procedure: Notes 8 and 9

- Sufficient vibration has occurred when the top surface of the concrete is relatively smooth.
- Over-vibration may cause segregation and loss of intentionally entrained air.

Procedure

- Following the consolidation process,
  - there should not be a substantial excess or deficiency of concrete in the measure
  - the optimum is approximately 3 mm of material above the rim of the measure
- If necessary,
  - a small amount of material may be added to correct a deficiency
  - representative material can be removed with a trowel or scoop

Procedure: Strike off

- Strike off the top surface using a flat strike-off plate.
  - produce a smooth finish to the top surface
- Strike off should result in a measure that is just level full.

Procedure: Strike off

- While pressing down,
  - cover 2/3 of the concrete surface
  - push down and pull back with a sawing motion
  - keep plate level and in contact with the measure at all times

Procedure: Strike off

- While pressing down,
  - cover the same 2/3 of the concrete surface
  - push down and advance the plate forward with a sawing motion
  - move the plate across the entire surface until its back edge slides completely off the measure
  - keep the plate level and in contact with the measure at all times

Procedure: Strike off

- Incline the plate and use an edge to produce a smooth finished surface.

Procedure: Clean and Weigh

- Clean the exterior of the measure and determine its mass (weight) when full.

Procedure

Calculation

- Density (unit weight), kg/m^3

$$= \frac{\text{Mass of measure full - Mass of measure empty}}{\text{Volume of measure}}$$

- Yield, m^3

$$= \frac{\text{Total mass of all batched material}}{(\text{Density})}$$

Calculation

- Relative Yield

$$= \frac{\text{Actual Yield}}{\text{Design (Intended) Yield}}$$

- Ratio of Actual Concrete Obtained to Volume as Designed
  - Value greater than 1.00 indicates excessive concrete being produced.
  - Value less than 1.00 indicates short designed volume

Calculation

- Air Content, %

$$= \left(\frac{\text{Theoretical Density - Measured Density}}{\text{Theoretical Density}} \right) \text{x100} \ \ \%$$

Terminology

- ***Theoretical Density:*** density of the concrete computed on an air free basis, kg/m^3.
  - density computed based on the mass and volume of the liquids and solids only
  - volume occupied by air (both entrapped and entrained) is taken as zero
  - T = M / V
  - M = Σ M = Σ [all masses]
  - V = Σ V = Σ [Mass / (1000*Specific Gravity)]

Report

- Identification of concrete and date of test.
- Report the test results as follows.
  - volume of measure to the nearest 0.01 L
  - density to the nearest 1.0 kg/m^3
- When requested, report
  - yield to the nearest 0.1 m^3
  - relative yield to the nearest 0.01
  - cement content to the nearest 0.5 kg
  - air content to the nearest 0.1 %

Limitations and Errors

- Determine the volume of the measure at least once a year.
- Tap the sides of the measure with a rubber mallet to close any voids. Voids cause the unit weight to be lower than the true value.
- In the filing of the container, add concrete and not mortar to ensure proportions remain the same.
- Use a flat plate to strike off the concrete. Tamping rod, trowel, float, or straight-edge will leave high spots.
- Wipe off the outside of the measure after filling.

Overview

Fresh Concrete Sampling and Testing

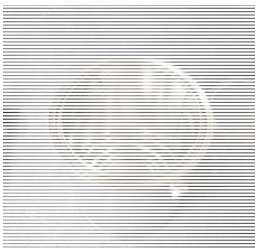
- ASTM C172 – Sampling Freshly Mixed Concrete
- ASTM C31 – Making and Curing Concrete Test Specimens
- ASTM C143 – Slump of Concrete
- ASTM C138 – Density (Unit Weight), Yield, and Air Content
- ***ASTM C403 – Time of Setting Concrete***
- ASTM C232 – Bleeding of Concrete

Significance of ASTM C403 – Setting Time

- Since the setting of concrete is a gradual process, any definition of time of setting must necessarily be arbitrary. In this test method, the times required for the mortar to reach specified values of resistance to penetration are used to define times of setting.
- To determine the effects of variables
  - i.e. water content; brand, type and amount of cementitious material; or admixtures upon the time of setting of concrete.
- To determine compliance with specified time-of-setting requirements.
- May also apply to mortars and grouts.

Apparatus - Containers for Mortar Specimens

- Rigid, watertight, nonabsorptive, free of oil or grease, and either cylindrical or rectangular in cross section
- Surface area allow for ten undisturbed penetration readings
- The lateral dimension shall be at least 6 in. [150 mm] and the height at least 6 in. [150 mm]



Apparatus – Penetration Needles

- Needles bearing areas: 1, ½, ¼, 1⁄10, 1⁄20, and 1⁄40 in.^{2} [645, 323, 161, 65, 32, and 16 mm^2]
- Each needle shank shall be scribed circumferentially at a distance 1 in. [25 mm] from the bearing area

Apparatus - Loading Apparatus

- A device shall be provided to measure the force required to cause penetration of the needles
- he device shall be capable of measuring the penetration force with an accuracy of 62 lbf [10 N] and shall have a capacity of at least 130 lbf [600 N]

Sampling, Test Specimens, and Test Units

- For tests under ***field*** conditions:
- prepare ***three*** specimens from each sample of concrete
- Obtain representative concrete in accordance to ASTM C172.
  - Perform and recod slump (Test Method ASTM C143, and air content (Test method ASTM C231 or C173) of the fresh concrete.
- From the concrete not used in the slump air content a representative portion of sufficient volume to fill the test container to at least 140 mm.

Sampling, Test Specimens, and Test Units

- For tests under ***laboratory*** conditions:
- For tests under laboratory conditions, the requirements depend upon the purpose of the tests
  - 7.2.1 To prove compliance of a material with performance requirements prepare three separate concrete batches for each variable under investigation.
  - 7.2.2 For other tests, prepare three test specimens from one batch of concrete for each test variable.

Example to Follow: Laboratory Mixed Concrete

Procedure: Sampling and Wet-Sieving

1. Obtain a representative sample and wet-sieve following procedures outlined in ASTM C172.

2. Thoroughly remix the mortar by hand methods.

Procedure: Preparing Sample

3. Place the mortar in containers in one layer. Remove voids by rocking or tapping the sides.

4. Mortar shall be at least ½ in. (10 mm) below top edge. Further level the surface of the mortar.

Procedure: Starting Test

5. Prior to making a penetration, remove bleed water from the surface.

6. To prevent excessive evaporation, cove the specimens with a tight fitting lid.