T 152

AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD

FOP for AASHTO

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01

Significance

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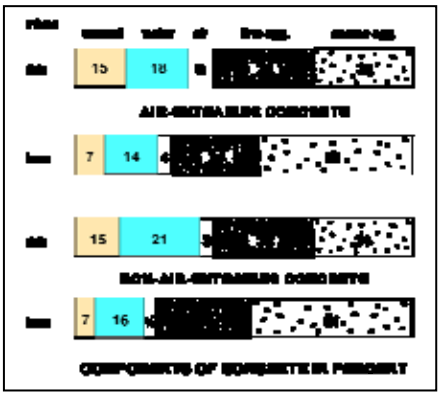
Concrete is not a solid, but rather a solid with void spaces. The voids may contain gas such as air, or liquid, such as water. All concrete contains air voids, and the amount can be increased by the addition of an air-entraining agent to the mix. When such an agent is used, the size of the voids drastically decreases and the number of voids greatly increases, providing a much greater dispersal of voids.



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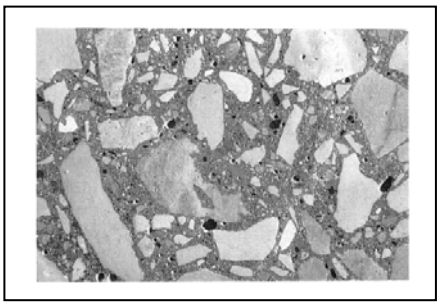
Air entrainment is necessary in concrete that will be saturated and exposed to cycles of freezing and thawing, and to deicing chemicals. The microscopic entrained air voids provide a site for relief of internal pressure that develops as water freezes and thaws inside the concrete. Without the proper entrained-air content, normal concrete that is saturated and is exposed to cycles of freezing and thawing can fail prematurely by scaling, spalling, or cracking.



Air Voids

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Care must be taken, however, not to have too much entrained air. As the air content increases, there will be a corresponding reduction in the strength and other desirable properties of the concrete. Typically, this strength reduction will be on the order of 3 to 5 percent for each 1 percent of air content. A concrete mix design proportioned for 5 percent air, for example, will be approximately 15 to 25 percent lower in strength if the air content were to double.

Scope

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This procedure covers determination of the air content in freshly mixed Portland Cement Concrete containing dense aggregates in accordance with AASHTO T 152, Type B meter. It is not for use with lightweight or highly porous aggregates. This procedure includes calibration of the Type B air meter gauge, and two methods for calibrating the gauge are presented. Concrete containing aggregate that is larger than 2” must be wet sieved. Sieve a sufficient amount of the sample over the 1½” sieve in accordance with the wet sieving portion of the

Apparatus

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FOP for WAQTC TM 2.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Air meter: Type B, as described in AASHTO T 152.
- Balance or scale: Accurate to 0.3 percent of the test load at any point within the range of use (for Method 1 calibration only).
- Tamping rod: 5/8 in. diameter and approximately 24 in. long, having a hemispherical tip. (Hemispherical means half a sphere; the tip is rounded like half of a ball.)
- Vibrator: 7000 vibrations per minute, 0.75 to 1.50 in. in diameter, at least 3 in. longer than the section being vibrated for use with low slump concrete.
- Scoop
- Container for water: rubber syringe (may also be a squeeze bottle).
- Strike-off bar: Approximately 12 in. x 3/4 in. x 1/8 in.
- Strike-off Plate: A flat rectangular metal plate at least 1/4 in. thick or a glass or acrylic plate at least 1/2 in. thick, with a length and width at least 2 in. greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within tolerance of 1/16 in.

Note 1: Use either the strike-off bar or strike-off plate; both are not required.

Mallet: With a rubber or rawhide head having a mass of 1.25 ±0.5 lb.

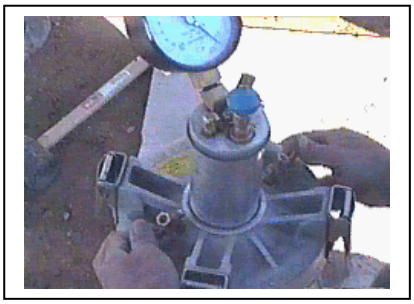
Calibration of Air Meter Gauge

09 ***Note 2:*** There are two methods for calibrating the air meter, mass or volume.

10 1. Screw the short piece of straight tubing into the threaded petcock hole on the underside of the cover. Determine the mass of the dry, empty air meter bowl and cover assembly. (Mass Method only)

2. Fill the bowl nearly full with water.

3. Clamp the cover on the bowl with the tube extending down into the water. Mark the petcock with the tube attached for future reference.



11 **Meter cover with petcocks**

4. Add water through the petcock having the pipe extension below until all air is forced out the other petcock. Rock the meter slightly until all air is expelled through the petcock.

12 5. Wipe off the air meter bowl and cover assembly, and determine the mass of the filled unit (Mass Method only).

6. Pump up the air pressure to a little beyond the predetermined initial pressure indicated on the gauge. Wait a few seconds for the compressed air to cool, and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.

13 **Gauge reading zero**

7. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle stabilizes. The gauge should now read 0 percent. If two or more tests show a consistent variation from 0 percent in the result, change the initial pressure line to compensate for the variation, and use the newly established initial pressure line for subsequent tests.

8. Determine which petcock has the straight tube attached to it. Attach the curved tube to external portion of the same petcock.

9. Pump air into the air chamber. Open the petcock with the curved tube attached to it. Open the main air valve for short periods of

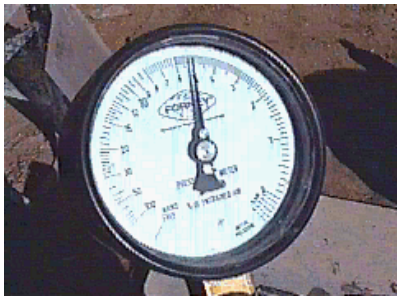
14 time until 5 percent of water by mass or volume

has been removed from the air meter. Remember to open both petcocks to release the pressure in the bowl and drain the water in the curved tube back into the bowl. To determine the mass of the water to be removed, subtract the mass found in Step 1 from the mass found in Step 5. Multiply this value by 0.05. This is the mass of the water that must be removed. To remove 5 percent by volume, remove water until the external calibration vessel is level full.

Note3: Many air meters are supplied with a calibration vessel(s) of known volume that are used for this purpose. Calibration vessel(s) should be brass, not plastic, and must be protected from crushing or denting. If an external calibration vessel is used, confirm what percentage volume it represents for the air meter being used. Vessels commonly represent 5 percent volume, but they are for specific size meters. This should be confirmed by mass.

15 10. Pump up the air pressure to a little beyond the predetermined initial pressure indicated on the gauge. Wait a few seconds for the compressed air to cool, and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.

11. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle is stabilized. The gauge should now read 5.0 ±0.1 percent. If the gauge is outside that range, the meter needs adjustment. The adjustment could involve adjusting the starting point so that the gauge reads 5.0 ±0.1 percent when this calibration is run, or could involve moving the gauge needle to read 5.0 percent. Any adjustment should comply with the manufacturer's recommendations.



Air meter gauge reading 5.0%

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Note 4: Calibration shall be performed at the frequency required by the agency. Record the date of the calibration, the calibration results, and the name of the technician performing the calibration in the logbook kept with each air meter.

12. When the gauge hand reads correctly at 5.0 percent, additional water may be withdrawn in the same manner to check the results at other values such as 10 percent or 15 percent.

13. If an internal calibration vessel is used follow steps 1 thru 8 to set initial reading.
14. Release pressure from the bowl and remove cover. Place the internal calibration vessel into the bowl. This will displace 5 percent of the water in the bowl. (See AASHTO 152 for more information on internal calibration vessels.)
15. Place the cover back on the bowl and add water through the petcock until all the air has been expelled.
16. Pump up the air pressure chamber to the initial pressure. Wait a few seconds for the compressed air to cool, and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.
17. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle stabilizes. The gauge should now read 5 percent.

Note 5: Remove the extension tubing from threaded petcock hole in the underside of the cover before starting the test procedure.

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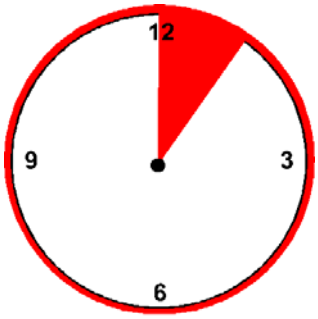
Procedure Selection

There are two methods of consolidating the concrete – rodding and internal vibration. If the slump is greater than 3 in., consolidation is by rodding. When the slump is 1 to 3 in., internal vibration or rodding can be used to consolidate the sample, but the method used must be that required by the agency in order to obtain consistent, comparable results. For slumps less than 1 in., consolidate the sample by internal vibration.



5 Minutes!

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Procedure - Rodding

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If any aggregate larger than 2” is present, aggregate must be removed in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2, using a 1½” sieve.

Note 6: Testing shall begin within five minutes of obtaining the sample.

Consolidation

2. Dampen the inside of the air meter bowl and place on a firm level surface.
3. Fill the bowl approximately 1/3 full with concrete.
4. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. Rod throughout its depth without hitting the bottom too hard.
5. Tap the sides of the bowl smartly 10 to 15 times with the mallet to close voids and release trapped air.
6. Add the second layer, filling the bowl about 2/3 full.
7. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. into the bottom layer.
8. Tap the sides of the bowl 10 to 15 times with the mallet.
9. Add the final layer, slightly overfilling the bowl.
10. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. into the second layer.
11. Tap the sides of the bowl smartly 10 to 15 times with the mallet.

Note 7: The bowl should be slightly over full, about 1/8 in. above the rim. If there is a great excess of concrete, remove a portion with the trowel or scoop. If the bowl is under full, add a small quantity. This adjustment may be done only after consolidating the final layer and before striking off the surface of the concrete.

12. Strike off the surface of the concrete and finish it smoothly with a sawing action of the strike-off bar or plate, using great care to leave the bowl just full. The surface should be smooth and free of voids.
13. Clean the top flange of the bowl to ensure a proper seal.
14. Moisten the inside of the cover and check to see that both petcocks are open and the main air valve is closed.
15. Clamp the cover on the bowl.
16. Inject water through a petcock on the cover until

Strike off

water emerges from the petcock on the other side.

17. Jar and or rock the air meter gently until no air bubbles appear to be coming out of the second petcock. The petcock expelling water should be higher than the petcock where water is being introduced. Return the air meter to a level position and verify that water is present in both petcocks.

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18. Close the air bleeder valve and pump air into the air chamber until the needle goes past the initial pressure determined for the gauge. Allow a few seconds for the compressed air to cool.

19. Tap the gauge gently with one hand while slowly opening the air bleeder valve until the needle rests on the initial pressure. Close the air bleeder valve.

Tapping air meter gauge

20. Close both petcocks.

21. Open the main air valve.

22. Tap the sides of the bowl smartly with the mallet.

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23. With the main air valve open, lightly tap the gauge to settle the needle, and then read the air content to the nearest 0.1 percent.

24. Release or close the main air valve.

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25. Open both petcocks to release pressure, remove the concrete, and thoroughly clean the cover and bowl with clean water.

26. Open the main air valve to relieve the pressure in the air chamber.

27 **Procedure - Internal Vibration**

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If any aggregate larger than 2" is present, aggregate must be removed in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2, using a 1½" sieve.
2. Dampen the inside of the air meter bowl and place on a firm level surface.
3. Fill the bowl approximately half full.
4. Insert the vibrator at three different points. Do not let the vibrator touch the bottom or sides of the bowl.

28 ***Note 8:*** Remove the vibrator slowly, so that no air pockets are left in the material.

Note 9: Continue vibration only long enough to achieve proper consolidation of the concrete. Over vibration may cause segregation and loss of appreciable quantities of intentionally entrained air.

5. Fill the bowl a bit over full.
6. Insert the vibrator as in Step 4. Do not let the vibrator touch the sides of the bowl, and penetrate the first layer approximately 1 in.
7. Return to Step 12 of the rodding procedure and continue.

Report

- Results shall be reported on standard forms approved for use by the agency.

29
- Record the percent of air to the nearest 0.1 percent.
- Some agencies require an aggregate correction factor in order to determine total percent entrained air.

  Total % entrained air =

  Gauge reading – aggregate correction factor from mix design

  (See AASHTO T 152 for more information.)

Tips! 30

- Start within 5 minutes of obtaining sample.
- Use a calibrated air meter.
- Protect the calibration vessel from damage.
- Consolidation technique depends on slump. Rodding and/or vibration may be appropriate for different slumps.

REVIEW QUESTIONS

1. Can the pressure method of determining air content be used on all types of concrete? Explain.

2. What are the required characteristics of the tamping rod used in this test method?

3. What is the specified size of the mallet required for this test method?

4. Describe the calibration process by mass and volume.

5. After rodding each layer, what should be done to the measure before adding another layer of concrete?

6. What tools may be used for striking off the top surface of the concrete following consolidation of the final layer?

7. What must be done if there is a slight deficiency in the quantity of concrete in the measure following consolidation of the final layer?

8. What must be done if there is an excessive amount of concrete in the measure following consolidation of the final layer?

PERFORMANCE EXAM CHECKLIST

AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD FOP FOR AASHTO T 152

Participant Name _____ Exam Date _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Representative sample selected?	_____	_____
2. Dampened container filled in three equal layers, slightly overfilling the last layer?	_____	_____
3. Each layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
4. Bottom layer rodded throughout its depth, without forcibly striking the bottom of the container?	_____	_____
5. Middle and top layers rodded, each throughout their depths and penetrating 1 in. into the underlying layer?	_____	_____
6. Sides of the container tapped 10 to 15 times with the mallet after rodding each layer?	_____	_____
7. Concrete struck off level with top of container using the bar or strike-off plate and rim cleaned off?	_____	_____
8. Top flange of base cleaned?	_____	_____
Using a Type B Meter:		
9. Both petcocks open?	_____	_____
10. Air valve closed between air chamber and the bowl?	_____	_____
11. Inside of cover cleaned and moistened before clamping to base?	_____	_____
12. Water injected through petcock until it flows out the other petcock?	_____	_____
13. Water injection into the petcock continued while jarring and or rocking the meter to insure all air is expelled?	_____	_____
14. Air pumped up to just past initial pressure line?	_____	_____
15. A few seconds allowed for the compressed air to stabilize?	_____	_____
16. Gauge adjusted to the initial pressure?	_____	_____
17. Both petcocks closed?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
18. Air valve opened between chamber and bowl?	_____	_____
19. The outside of bowl tapped smartly with the mallet?	_____	_____
20. With the main air valve open, gauge lightly tapped and air percentage read to the nearest 0.1%?	_____	_____
21. Air valve released or closed and then petcocks opened to release pressure before removing the cover?	_____	_____
22. Aggregate correction factor applied if required?	_____	_____
23. Air content recorded to 0.1 percent?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

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Examiner Signature _____WAQTC #:_____

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