WSDOT FOP for WAQTC T 152[1]

Air Content of Freshly Mixed Concrete by the Pressure Method

Significance

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.

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.

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

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 would be retained on the 2 inch (50 mm) sieve must be wet sieved. Sieve a sufficient amount of the sample over the 1½ in (37.5 mm) sieve in accordance with the FOP for WAQTC TM 2.

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).
- Verified external or internal calibration vessel of known volume (usually 5 percent ± of the volume of the meter base).
- Tamping Rod – ⅝ inch (16 mm) diameter and approximately 24 inch (600 mm) long, having a hemispherical tip. (Hemispherical means half a sphere; the tip is rounded like half of a ball.)
- Vibrator – 7,000 vibrations per minute, 0.75 to 1.50 inch (19 to 38 mm) in diameter, at least 3 in (75 mm) longer than the section being vibrated for use with low slump concrete.
- Scoop.
- Container for Water – Rubber syringe (may also be a squeeze bottle).

[1]This FOP is based on WAQTC T 152 and has been modified per WSDOT standards. To view the redline modifications, contact the WSDOT Quality Systems Manager at 360-709-5412.

- Strike-Off Bar – Approximately 12 inch × ¾ inch × ⅛ inch (300 mm × 22 mm × 3 mm).
- Strike-Off Plate – A flat rectangular metal plate at least ¼ in (6 mm) thick or a glass or acrylic plate at least ½ in (12 mm) thick, with a length and width at least 2 in (50 mm) 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 inch (1.5 mm).

  Note 1: Use either the strike-off bar or strike-off plate; both are not required. Unit weight requires the use of a strike-off plate.
- Mallet – With a rubber or rawhide head having a mass of 1.25 ± 0.5 lb (0.57 ± 0.23 kg).

Calibration of Air Meter Gauge

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

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 base and cover assembly (Mass Method only).
2. Fill the base nearly full with water.
3. Clamp the cover on the base with the tube extending down into the water. Mark the petcock with the tube attached for future reference.
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.
5. Wipe off the air meter base 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.
7. Close both petcocks and immediately open the main air valve exhausting air into the base. 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 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 base and drain the water in the curved tube back into the base. 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 calibrating vessel is level full.

Note 3: Many air meters are supplied with a calibration vessel(s) of known volume that are used for this purpose. Calibration vessels must be protected from damage that would change their volume.

If an external or internal 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.

10. Remove the curved tube. 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 base. Wait a few seconds until the meter needle is stabilized. The gauge should now read 5.0 ± 0.2 percent. If the gauge is outside that range, the meter needs adjustment (consult the Regional Materials Laboratory). The adjustment could involve adjusting the starting point so that the gauge reads 5.0 ± 0.2 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.

    Note 4: Calibration shall be performed per agency standards, prior to field use, and weekly during construction use. Record the date of the calibration, the calibration results, and the name of the technician performing the calibration in the log book kept with each air meter.

    WSDOT Note: Air meter calibration standard for WSDOT:

    Regional Laboratory – Required to calibrate air meter yearly.

    Project Office – Required to calibrate air meter as follows:

    1. First Time Use Calibration – Calibrate air meter prior to first time use in the field each construction season or when the air meter has not been used for more than a month during the construction season.

    2. Construction Use Calibration – After "First Time Use Calibration," calibrate the air meter once a week when used during construction.

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.

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

    An internal calibration vessel of known volume, usually 5 percent of the volume of the bucket, may be employed as a quick method to verify the calibration of the air meter during construction use. To employ this vessel proceed as follows.

13. Fill the base nearly full with water and place the internal calibration vessel into the base. Place the cover back on the base and gently add water through the petcock until all the air has been expelled. Do not disturb the meter to such an extent as to knock the calibration vessel from an upright position. Do not install either of the threaded tubes into the petcock when using the calibration vessels.

14. Pump up the air pressure to a little beyond the predetermined initial pressure indicated in the calibration record log book. 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.

15. Close both petcocks and immediately open the main air valve exhausting air into the base. Wait a few seconds and gently tap the back of the gauge until the meter needle stabilizes. The gauge should now read 5.0 ± 0.2 percent or ± 0.2 percent of the volume indicated in the calibration vessel. If the gauge is outside of that range, follow step 1 through step 12 of the calibration procedure to recalibrate the air meter. If further adjustment is required, consult the Regional Materials Laboratory.

16. If necessary, additional vessels may be placed into the base to verify the calibration of the air meter at 10 percent volume and 15 percent volume or the sum of the volumes indicated on the individual calibration vessels.

17. Record the date that the calibration of the air meter was verified in the calibration log book.

18. Gently release the air pressure in the base by opening one of the petcocks, then remove and drain any water from within the calibration vessel and store it in a safe location. The air meter is now ready for use.

Procedure Selection

There are two methods of consolidating the concrete – rodding and vibration. If the slump is greater than 3 in (75 mm), consolidation is by rodding. When the slump is 1 to 3 in (25 to 75 mm), 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 (25 mm), consolidate the sample by internal vibration.

Procedure – Rodding

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If the concrete contains coarse aggregate particles that would be retained on a 2-in (50-mm) sieve, wet-sieve a sufficient amount of the representative sample over a 1½-in (37.5-mm) sieve, in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2. Contact the Materials Laboratory for directions.

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

2. Dampen the inside of the air meter base and place on a firm, level surface.

3. Fill the base approximately ⅓ 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 base smartly 10 to 15 times with the mallet to close voids and release trapped air.

6. Add the second layer, filling the base about ⅔ full.

7. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in (25 mm) into the bottom layer.

8. Tap the sides of the base 10 to 15 times with the mallet.
9. Add the final layer, slightly overfilling the base.
10. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in (25 mm) into the second layer.
11. Tap the sides of the base smartly 10 to 15 times with the mallet.

    Note 7: The base should be slightly over full, about ⅛ inch (3 mm) above the rim. If there is a great excess of concrete, remove a portion with the trowel or scoop. If the base 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 base just full. The surface should be smooth and free of voids as much as possible.
13. Clean the top flange of the base 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 base.
16. Inject water into one petcock until water emerges from the second petcock. (***Note:*** Water is injected into only one petcock during the entire procedure.)
17. 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 injected. Return the air meter to a level position and verify that water is present in both petcocks.
18. Close the air bleeder valve and pump air into the air chamber until the needle goes past the initial pressure line. 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 line. Close the air bleeder valve.
20. Close both petcocks.
21. Open the main air chamber valve.
22. Tap the sides of the base smartly with the mallet.
23. With the main air chamber valve open, lightly tap the gauge to settle the needle, and then read the air content to the nearest 0.1 percent, while the air chamber valve is open.
24. Release or close the main air chamber valve.
25. Open both petcocks to release pressure, remove the concrete, and thoroughly clean the cover and base with clean water.
26. Open the main air valve to relieve the pressure in the air chamber.

Procedure – Internal Vibration

1. Obtain the sample in accordance with FOP for WAQTC TM 2. If any aggregate larger than 2 in (50 mm) is present, the larger aggregate must be removed. Sieve a sufficient amount of the sample over the 1½ in (37.5 mm) sieve in accordance with the wet sieving portion of FOP for WAQTC TM 2. Contact the Materials Laboratory for directions.
2. Dampen the inside of the air meter bowl and place on a firm level surface.
3. Fill the base approximately half full.
4. Insert the vibrator at three different points. Do not let the vibrator touch the bottom or sides of the base.

   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 base a bit over full.
6. Insert the vibrator as in Step 3. Do not let the vibrator touch the sides of the base and penetrate the first layer approximately 1 in (25 mm).
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. Record the percent of air to the nearest 0.1 percent.

Report results on concrete delivery ticket (i.e., Certificate of Compliance).

The name of the tester who performed the field acceptance test is required on concrete delivery tickets containing test results.

Performance Exam Checklist

WSDOT FOP for WAQTC T 152
Air Content of Freshly Mixed Concrete by the Pressure Method

Participant Name _____ Exam Date _____

Procedure Element	Yes	No
1. The tester has a copy of the current procedure on hand?	☐	☐
2. All equipment is functioning according to the test procedure, and if required, has the current calibration/verification tags present?	☐	☐
3. Container filled in three equal layers, slightly overfilling the last layer?	☐	☐
4. Correct consolidation procedure chosen?	☐	☐
5. Rodding		
a. Each layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes?	☐	☐
b. Bottom layer rodded throughout its depth, without forcibly striking the bottom of the container?	☐	☐
c. Middle and top layers rodded, each throughout their depths and penetrating 1 inch (25 mm) into the underlying layer?	☐	☐
d. Sides of the container tapped 10 to 15 times with the mallet after rodding each layer?	☐	☐
6. Internal Vibration		
a. Aggregate larger than 1½ removed?	☐	☐
b. Inside of air meter dampened?	☐	☐
c. Base filled to approximately half full for first lift?	☐	☐
d. Vibrator inserted in three different locations without touching sides or base?	☐	☐
e. Vibrator removed slowly and concrete not over vibrated?	☐	☐
f. Base filled to just overfull?	☐	☐
g. Vibrator inserted approximately 1 inch into first layer in three different locations without touching sides?	☐	☐
Finishing		
7. Concrete struck off level with top of container and rim cleaned?	☐	☐

Using a Type B Meter	Yes	No
8. Both petcocks open?	☐	☐
9. Air valve closed between air chamber and the bowl?	☐	☐
10. Inside of cover cleaned and moistened before clamping to base?	☐	☐
11. Water injected through petcock until it flows out the other petcock?	☐	☐
12. Water injection into the petcock continued while tipping the meter to ensure all air is expelled?	☐	☐
13. Air pumped up to initial pressure line?	☐	☐
14. A few seconds allowed for the compressed air to stabilize?	☐	☐
15. Gauge adjusted to the initial pressure?	☐	☐
16. Both petcocks closed?	☐	☐
17. Air valve opened between chamber and bowl?	☐	☐
18. Sides of bowl tapped with the mallet?	☐	☐
19. With air valve open, Air percentage read after lightly tapping the gauge to stabilize the hand?	☐	☐
20. Air valve closed and then petcocks opened to release pressure before removing the cover?	☐	☐
21. Air content recorded to 0.1 percent?	☐	☐
22. All calculations performed correctly?	☐	☐

First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Signature of Examiner _____

Comments: