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concrete by pressure method**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Land, Infrastructure, Transport and Tourism through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Concrete Institute (JCI) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 14 of the said Act. Consequently **JIS A 1128:2014** is replaced with this Standard.

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Method of test for air content of fresh concrete by pressure method

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 1920-2** : 2016, Edition 2, with some modifications of the technical contents, mainly the addition of the no-water method.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JB.

1 Scope

This Standard specifies the method for determining the air content of fresh concrete through reduction of pressure in air chamber. This Standard is applicable to concrete made with ordinary aggregate of which the maximum aggregate size is 40 mm or smaller. It is not applicable to concrete made with porous aggregate such as artificial lightweight aggregate for which the aggregate correction factor cannot be accurately determined. The water-column method is provided in Annex A (informative).

NOTE 1 The test method specified in this Standard employs the principle of Boyle's law.

NOTE 2 The air chamber method is carried out either with or without water injection.

NOTE 3 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 1920-2 : 2016 *Testing of concrete — Part 2 : Properties of fresh concrete* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS A 1115 *Method of sampling fresh concrete*

NOTE Corresponding International Standard : ISO 1920-1 : 2004 *Testing of concrete — Part 1 : Sampling of fresh concrete* (MOD)

JIS A 1116 *Method of test for unit mass and air content of fresh concrete by mass method*

NOTE Corresponding International Standard : ISO 1920-2 : 2016 *Testing of concrete — Part 2 : Properties of fresh concrete* (MOD)

JIS A 1138 *Method of making test sample of concrete in laboratory*

JIS A 8610 *Building construction machinery and equipment — Internal vibrators for concrete*

3 Apparatus

3.1 Air meter, satisfying the following.

- a) The air meter shall be structured to allow injection of water into the space between the concrete and the cover as shown in Figure 1. In the case of no-water method, an apparatus designed for testing without water injection may be used.

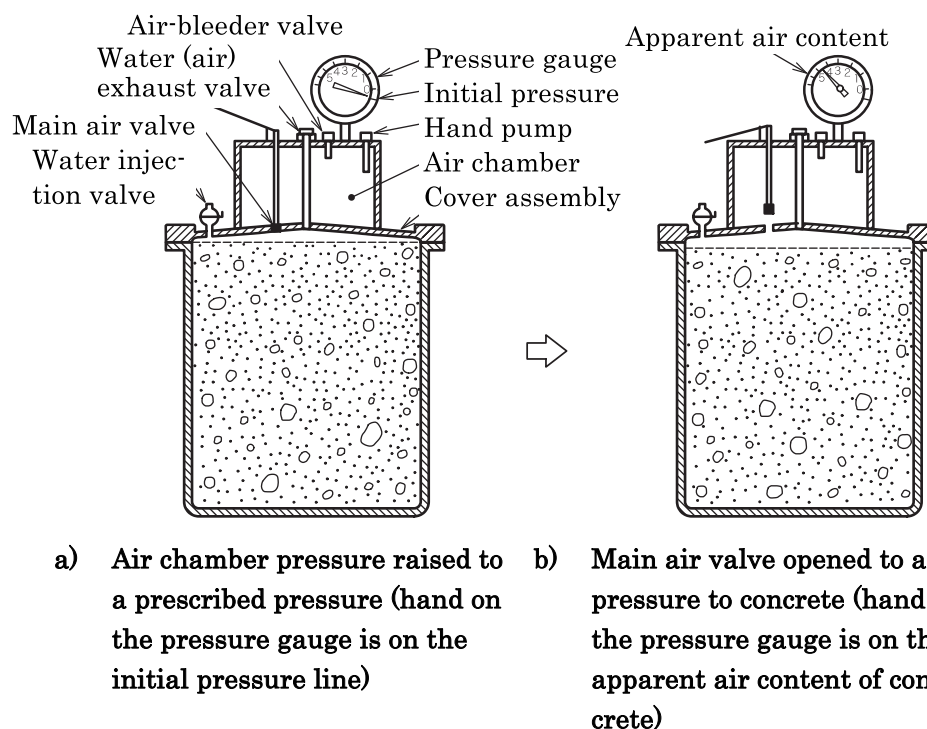


Figure 1 Air meter

- b) The container shall be a flanged cylindrical vessel, made of a material not readily attacked by cement paste, watertight, sufficiently rigid, having a diameter equal to 0.75 to 1.25 times the height, and a nominal capacity of at least 5 L in the case of water injection method, and about 7 L or greater in the case of no-water method.

The container shall be flanged to create good pressure seal with the cover under high pressure. The interior surfaces of the container and upper surface of the

flange shall be machined to a smooth finish.

- c) The cover assembly shall be flanged, made of, similarly to the container, a material not readily attacked by cement paste, water tight, sufficiently rigid, and provided with water injection valve and water (air) exhaust valve. The lower surfaces of the cover and the flange shall be machined to a smooth finish.
- d) An air chamber having an inner capacity of about 5 % of the capacity of the container shall be mounted on the upper surface of the cover.

The air chamber shall be provided with an air-bleeder valve, hand pump, pressure gauge and main air valve.

The main air valve, when the cover is clamped onto the container, shall have sufficient rigidity to endure a 100 kPa pressure without air or water leakage, and to limit the expansion under normal operating condition to not more than 0.1 % of air content. It shall be designed to allow venting of high pressure air in the air chamber into the container and prevent entrance of water into the air chamber.

- e) The pressure gauge shall have a capacity of about 100 kPa, and accuracy of about 1 kPa. The scale plate on the pressure gauge shall be at least 9 cm in diameter, graduated up to at least 8 % in air content (see 5.4), and marked with the initial pressure line (see 5.3).
- f) Devices for withdrawing water in the apparatus as necessary for the calibration purposes (50 mm long calibration pipe and extension tube as shown in Figure 2) shall be prepared.

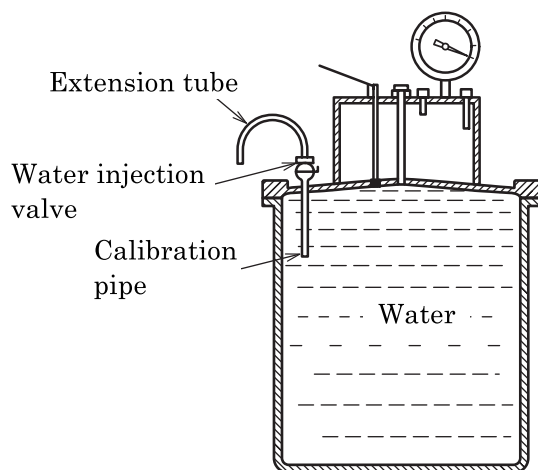


Figure 2 Attachment of calibration pipe and extension tube (example)

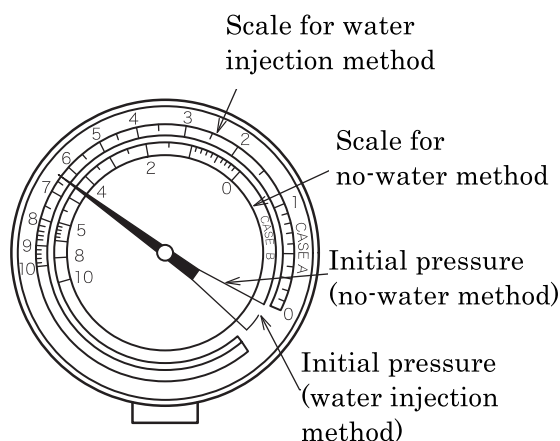


Figure 3 Scale plate on pressure gauge (example)

3.2 Vibrator, as specified in JIS A 8610, comprising a vibration head about 28 mm in nominal diameter.

3.3 Compacting rod, of circular cross-section, straight, made of steel or metal, having

a diameter of 16 mm, a length of 500 mm to 600 mm and with rounded, roughly hemispherical, ends.

4 Sample

Sample shall be taken according to the sampling method specified in **JIS A 1115** or ~~prepared according to the method specified in JIS A 1138.~~

5 Calibration of apparatus

5.1 General

The calibration of apparatus shall be as follows.

NOTE The apparatus should be calibrated as necessary before continuous measurement is started.

5.2 Calibration of container

The calibration of the container shall be as follows.

- a) Place the container on a flat surface, and smear a thin film of grease on the flange of the container.
- b) Fill the container with water up to about 90 % of its capacity. Place a polished glass plate over the container and while pouring the remaining water, slide the plate slowly, with care not to trap any air bubbles under it, in such a manner as to ensure that the container is completely filled with water.
- c) Measure the water temperature t_1 °C.
- d) Wipe any excessive water spilled from the container, and weigh the container and the glass plate to the nearest 1 g. Record this mass as m_1 .
- e) Drain the water in the container, wipe off water on the wall of the container, and weigh the container to the nearest 1 g. Record this mass as m_2 .
- f) Wipe off water on the glass plate and weigh the glass plate to the nearest 1 g. Record this mass as G_1 .
- g) Calculate the volume, V_C , of the container by the following formula.

$$V_C = \frac{m_1 - (m_2 + G_1)}{\rho_w}$$

where, ρ_w : density of water at temperature t_1 °C (g/cm³)

5.3 Determination of initial pressure

The determination of initial pressure shall be as follows.

- a) In the case of water injection method, fill the container with water, and after securing air vent through the cover, carefully mount the cover assembly attached with calibration device (see Figure 2) onto the container. Open the water exhaust valve and inject water through the water injection valve until the air entrapped in the space between the lower surface of the cover and the water surface has been expelled.

- b) In the case of no-water method, measure the temperature of the water before injecting it into the container. Multiply the volume of container by the density of water at this temperature, and round the result to the nearest 1 g. Take this value as the mass equivalent to the volume of container. After mounting the cover assembly attached with the calibration device onto the container, inject a mass of water equivalent to the volume of the container, measured to the nearest 1 g, through the water injection valve into the container.
- c) Close all the valves, and using the hand pump, pump air into the chamber until the pressure in the air chamber reaches slightly above the initial pressure. After about five seconds, gradually open the air-bleeder valve to stabilize the hand on the pressure gauge at the initial pressure line.
- d) Open the main air valve fully to allow the air pressure in the air chamber and pressure in the container to attain equilibrium, and see if the value indicated on the pressure gauge exactly equals the 0 % on the air content scale. If this was not the case, check for air and water leakage, and other abnormalities, and repeat the procedure. If, in two or three runs of procedure, the hand on the pressure gauge keeps indicating the same point but does not equal the zero point, move the initial pressure line so that the hand stays at the zero point. Repeat this procedure to check the accuracy of the initial pressure line.
- e) Read the scale for water injection method when performing the water injection method, and the scale for no-water method when performing no-water method (see Figure 3).

5.4 Calibration of air content graduations

The calibration of air content graduations for water injection method and no-water method shall be as follows.

- a) Perform the following after the procedure in **5.3 a)** in the case of water injection method and after the procedure in 5.3 b) in the case of no-water method.
 - 1) Using the device specified in 3.1 f), remove about 100 ml to 140 ml of water (approximately 2 % in air content) from the container to a measuring cylinder and express the volume of water removed as a percent to the volume of container.
 - 2) After waiting for the air pressure in the container to become equal to the atmospheric pressure, close all the valves and allow the air pressure in the air chamber to reach the initial pressure.
 - 3) Open the main air valve to allow the high pressure air into the container.
 - 4) When the hand on the pressure gauge has stabilized, read the indicated value of air content.
- b) Repeat the procedure in **a)** to remove water from the container, and express the total volume of the water removed as a percent to the volume of container. Read the indicated value of air content similarly to **a).**
- c) Perform the above procedure four to five times (at a pitch of approximately 2 % in

air content), and compare the percent of the volume of water removed to the volume of container and the indicated value of air content (%).

- d) Alternatively, the mass of water removed in procedures a) to c) may be measured and divided by the density of water to determine the volume.
- e) If the compared values are in agreement, the accuracy of the air content graduations shall be considered as verified. If the values are not in agreement, establish a relation between them by an appropriate method, and use this relation to calibrate the air content graduations.

NOTE For the hand on the gauge to stabilize, lightly tap the pressure gauge before taking the reading.

6 Determination of aggregate correction factor

Determination of aggregate correction factor shall be as follows ¹⁾.

Note ¹⁾ The aggregate correction factor will vary with different aggregates; although ordinarily it will remain reasonably constant for aggregate belonging to the same lot, an occasional check should be carried out.

- a) Calculate the masses of fine and coarse aggregate in a concrete sample of volume V_C to be tested for air content ²⁾ :

$$m_f = \frac{V_C}{V_B} \times m_f'$$

$$m_c = \frac{V_C}{V_B} \times m_c'$$

where,

- m_f : mass of fine aggregate in concrete sample of volume V_C (kg)
- m_c : mass of coarse aggregate in concrete sample of volume V_C (kg)
- V_B : volume of one batch of concrete (L)
- V_C : volume of concrete sample (equal to the volume of the container) (L)
- m_f' : mass of fine aggregate used for one batch of concrete (kg)
- m_c' : mass of coarse aggregate used for one batch of concrete (kg)

Note ²⁾ The sample of aggregate may be obtained by washing the cement through a 150 μ m sieve from the concrete sample having been tested for air content.

- b) Obtain the masses, m_f and m_c , of sample from fine aggregate and coarse aggregate. Fill the container of the apparatus with water up to one-third of its capacity, then introduce the combined sample of aggregate in small scoopfuls until all of the aggregate is inundated ³⁾. This shall be done in such a manner as to entrap as little air as possible, while quickly removing any foam generated. To remove air trapped, tap the sides of the container with a mallet etc. and after addition of each scoopful of fine aggregate, tamp the aggregate using a compacting rod with about 10 strokes ensuring each stroke reaches a depth of 25 mm.

Note ³⁾ The obtained fine and coarse aggregate sample should be immersed in

water for about 5 min to be brought to a moisture condition similar to that in the concrete sample.

- c) When all the aggregate has been placed in the container, remove all the air trapped on the water surface, wipe clean the flanges of the container and the cover assembly thoroughly, fit the cover with rubber packing, clamp the cover assembly into position, and inject water until water emerges from the water (air) exhaust valve. Close all the valves, and using the hand pump, pump air into the air chamber until the pressure in the air chamber reaches slightly above the initial pressure. After about five seconds, gradually open the air-bleeder valve to stabilize the hand on the pressure gauge at the initial pressure line. Open the main air valve fully to allow the air pressure in the air chamber and pressure in the container to reach equilibrium, and read the value indicated on the pressure gauge. Take this value as aggregate correction factor, G . If necessary, correct the gauge reading based on the relation determined in 5.4 e).

7 Determination of air content of concrete

The determination of air content of concrete shall be as follows.

- a) In compaction using a compacting rod, fill the container with sample up to about one-third of its capacity, even the sample surface, and tamp the sample using a compacting rod with 25 strokes evenly distributed over the surface while ensuring none of the strokes reach the bottom of the container. Tap the outer wall of the container with a mallet etc. 10 to 15 times until depressions left by the compacting rod are removed and large bubbles of air cease to appear on the concrete surface. If the concrete under test has high fluidity, the number of tamping and/or tapping strokes may be reduced as far as sufficient compaction can be achieved. Add sample up to approximately two-thirds of the height of the container, and repeat the above procedure. Finally heap the sample slightly above the container and repeat the same procedure, and scrape off the surface of the sample level with the top of the container with a straightedge. In compacting each layer, the compacting rod shall penetrate throughout the depth of the uppermost layer to reach just into the underlying layer.
- b) If compacting using a vibrator, follow the procedure in 5.2 of JIS A 1116. Fill the container with sample up to half its capacity, and compact the layer by three insertions of the vibrator evenly distributed over the surface. Heap the sample slightly above the container, and repeat the same procedure. When compaction is complete, remove the vibrator by steady uplift motion with care not to leave any air pockets in concrete. In compacting of the upper layer, the vibrator shall penetrate throughout the depth of the upper layer so that the tip of the vibrator just reaches into the underlying layer. For each layer, apply vibration for the minimum duration necessary for large bubbles of air to cease to appear on the concrete surface. After the top layer has been compacted, scrape off the surface of the sample level with the top of the container with a straightedge. This mechanical compaction shall not be used for any sample with a slump of 8 cm or more.

- c) Wipe clean the upper surface of the flange of the container and the lower surface of the flange of the cover assembly thoroughly and clamp the cover assembly into position so that there is a good seal between the cover and the container.
- d) Inject water through the water injection valve while lightly tapping the apparatus until water emerges from the water exhaust valve and the air entrapped in the space between the lower surface of the cover and the water surface has been expelled. ~~This procedure does not apply to the no-water method.~~ Close all the valves.
- e) By means of the hand pump, pump air into the air chamber until the pressure in the air chamber reaches slightly above the initial pressure. After about five seconds, gradually open the air-bleeder valve to stabilize the hand on the pressure gauge at the initial pressure line while tapping the pressure gauge. After about five seconds, open the main air valve fully, and tap the sides of the container with a mallet etc.

Open fully the main air valve again and wait for the hand on the gauge pressure to stabilize. Read the value indicated on the pressure gauge to the nearest 0.1 %, and record it as the apparent air content of concrete, A_1 . If necessary, correct the gauge reading based on the relation determined in 5.4 e).

- f) When the test is complete, open both the water injection valve and the water (air) exhaust valve in order to release the pressure before the cover assembly is removed. The main air valve shall not be opened before pressure has been released from both the container and the air chamber ⁴⁾.

Note ⁴⁾ Otherwise water will be drawn into the air chamber and render subsequent measurements inaccurate.

8 Calculation

The calculation shall be as follows.

- a) **Air content of concrete** Calculate the air content, A , by the following formula.

$$A = A_1 - G$$

where, A : air content of concrete (%)
 A_1 : apparent air content of concrete (%)
 G : aggregate correction factor ⁵⁾ (%)

Note ⁵⁾ ~~This may be omitted if smaller than 0.1 %.~~

- b) **Air content of full mixture** When air content, A , has been determined on the concrete made with aggregate of maximum size greater than 40 mm after sieving to exclude aggregate particles greater than 40 mm, the air content, A_f , of full mixture shall be calculated by the following formula :

$$A_f = 100 \times A \times V_c / (100 \times V_t - A \times V_a)$$

where, V_c : absolute volume of the concrete mixture passing a 40 mm sieve, airfree, as determined from the original batch masses (m^3)
 V_t : absolute volume of the concrete mixture before sieving, airfree (m^3)

V_a : absolute volume of the aggregate in the mixture larger than 40 mm, as determined from the original batch masses (m^3)

- c) **Air content of the mortar fraction** Calculate the air content, A_m , of the mortar fraction of the concrete by the following formula.

$$A_m = 100 \times A \times V_C / [100 \times V_m + A(V_C - V_m)]$$

where, V_m : absolute volume of the constituents of the mortar fraction of the concrete, airfree, as determined from the original batch masses (m^3)

9 Test report

The test report shall include the following information.

a) **Information to be always included**

- 1) Air content of concrete (%)

b) **Additional information to be included if necessary**

- 1) Date of test
- 2) Sample identification (symbol or number)
- 3) Mix details of concrete
- 4) Method used (water injection or no-water)
- 5) Method of compaction
- 6) Unit mass (kg/m^3)
- 7) Temperature of concrete at the time of test ($^{\circ}\text{C}$)
- 8) Slump or slump flow (cm)
- 9) Temperature in laboratory or test site ($^{\circ}\text{C}$)
- 10) Calculated air content of full mixture (%)
- 11) Calculated air content of the mortar fraction (%)
- 12) Maximum coarse aggregate size (mm)
- 13) Type and class of aggregate
- 14) Aggregate correction factor (%)
- 15) Type of admixture (%)