Transport Roads & Maritime Services

Test Method T377

Water permeability of no fines concrete (Falling head laboratory permeameter)

Issue No: 4

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About this release

Title:	Water permeability of no fines concrete (Falling head laboratory permeameter)
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Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
Issue 4	All	Reformatted RMS template Changes to Sections 2(b) and (d), and, 3(a), (c), (g) and (h, 5.1(c), 5.2(g) & (h) and 7.	S Yuen	August 2016
Ed 3/ Rev 0	All	Reformatted RMS template	J Friedrich	October 2012
Ed 2/ Rev 0	All	New format Height range broadened Saw required for trimming	D Hazell	October 2011
Ed 1/ Rev 0	All	New Method	D Hazell	July 2010

Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test Method T377 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

The key revisions to Issue 4 are improvements to the text and the use PVC ducting tape to seal the sample. Also, the sample must be photographed before the test is conducted.

Test Method T377

Water permeability of no fines concrete (Falling head laboratory permeameter)

1. SCOPE

This test method sets out the procedure to measure the water permeability of no fines concrete (NFC) using the laboratory permeameter. The method is based on Roads and Maritime Test Method T655 and Queensland Department of Main Roads Test Method Q304.

2. GENERAL

(a) The test measures the amount of water that passes through a cylindrical specimen where the walls are sealed and the specimen has been brought to a saturated state.

NOTE: The test is generally applicable to permeability in the range 4.5×10^{-5} to 2×10^{-2} m/s.

(b) Carry out this test after determination of mass of the sample under water and at saturated surface dry condition for calculation of void content in the Test Method T378.

NOTE: Dry the sample and determine the dry mass for calculation of void content in the RMS Test Method T378 after conducting the permeability test.

(c) This test is carried out on a core taken on site or a specimen moulded in the laboratory. The specimen has a diameter of 150 ±5 mm and height in the range 1.50 to 2.05 times the actual diameter of the specimen.

(d) The following documents are referred to in this Test Method:

i) T376 Moulding of No Fines Concrete Specimens

ii) T378 Void Content of No Fines Concrete

iii) AS 1012.14 Methods of testing concrete - Method for securing and testing cores from hardened concrete for compressive strength

3. APPARATUS

(a) Clear plastic graduated cylinder at least 1.2 m in length and a diameter that will align vertically flush with the specimen (i.e. about 150 mm outside diameter). The top marker is to be at 1.0 m and the bottom marker is to be positioned to meet Step 5.1(f).

(b) A support for holding the specimen in a fixed position without constricting the flow of water though the base of the sample.

(c) Timing device accurate to ± 0.1 s.

NOTE: Stop watch or digital timer is suitable

(d) Vernier callipers readable to 0.1 mm.

(e) 300 mm steel rule graduated in 1 mm increment.

(f) Material to provide a watertight seal on the side walls of the specimen:

i) PVC ducting tape

OR

ii) Seamless rubber membrane tube with internal diameter about 5 mm less than the specimen diameter; thickness of 0.1 to 0.4 mm; and length at least 50 mm more than the specimen height. A membrane stretcher to suit the size of the specimen

OR

iii) A PTFE or FEP heat-shrink plastic sleeve of a diameter that when activated forms a watertight seal on the walls of the specimen.

(g) Supply of water at a temperature in the range 15 to 25°C.

(h) An immersion thermometer graduated from 0 to 100°C.

(i) A masonry or diamond saw for accurately trimming specimens.

4. PREPARATION

(a) The test is carried out on either a core or laboratory specimen:

i) Where a specimen of the required dimensions has been prepared and tested using T378 proceed to Step 5.1(b)

OR

ii) Secure a nominal 150 mm diameter core in accordance with AS 1012.14. Inspect the core and reject any core that has cracking or defect that cannot be removed by trimming

OR

iii) Prepare and mould laboratory specimens according T376.

(b) Trim approximately 20 mm from each end of the specimen to remove irregularities and slurry. Ensure the following requirements are achieved after trimming:

i) A final height in the range 1.50 to 2.05 times the actual diameter of the specimen.

ii) Parallel ends and no more than 5 mm out of square from the vertical axis.

iii) The edges of the specimen are not fretted.

5. PROCEDURE

5.1 Setting up

(a) Using Vernier callipers, determine the average height (h_m) and diameter (D_m) of the specimen to the nearest 0.1 mm using 3 measurements of each dimension.

(b) Measure the following dimensions on the apparatus:

i) Distance (h) between the top and bottom marker

ii) Internal diameter (D) of the cylinder

(c) Photograph the top, bottom and the sides of the sample (three photographs of the side of the sample taken at least 90° apart) before sealing.

(d) Completely seal the circumferential surface of the specimen using either:

i) PVC ducting tape

OR

ii) Stretching and applying a seamless rubber membrane over the specimen to create a tight fit

OR

iii) A PTFE or FEP heat-shrink plastic sleeve to form a watertight seal with the outer surface of the specimen

(e) Set up the specimen and graduated cylinder as follows (refer to Figure 1):

i) Position the specimen level on a support in a sink or container of sufficient capacity.

ii) Attach the bottom of the plastic graduated cylinder to the specimen to make a watertight seal by wrapping the PVC duct tape over the cylinder to affect a seal. If a membrane or sleeve is used, stretch the top end over the cylinder to affect a seal.

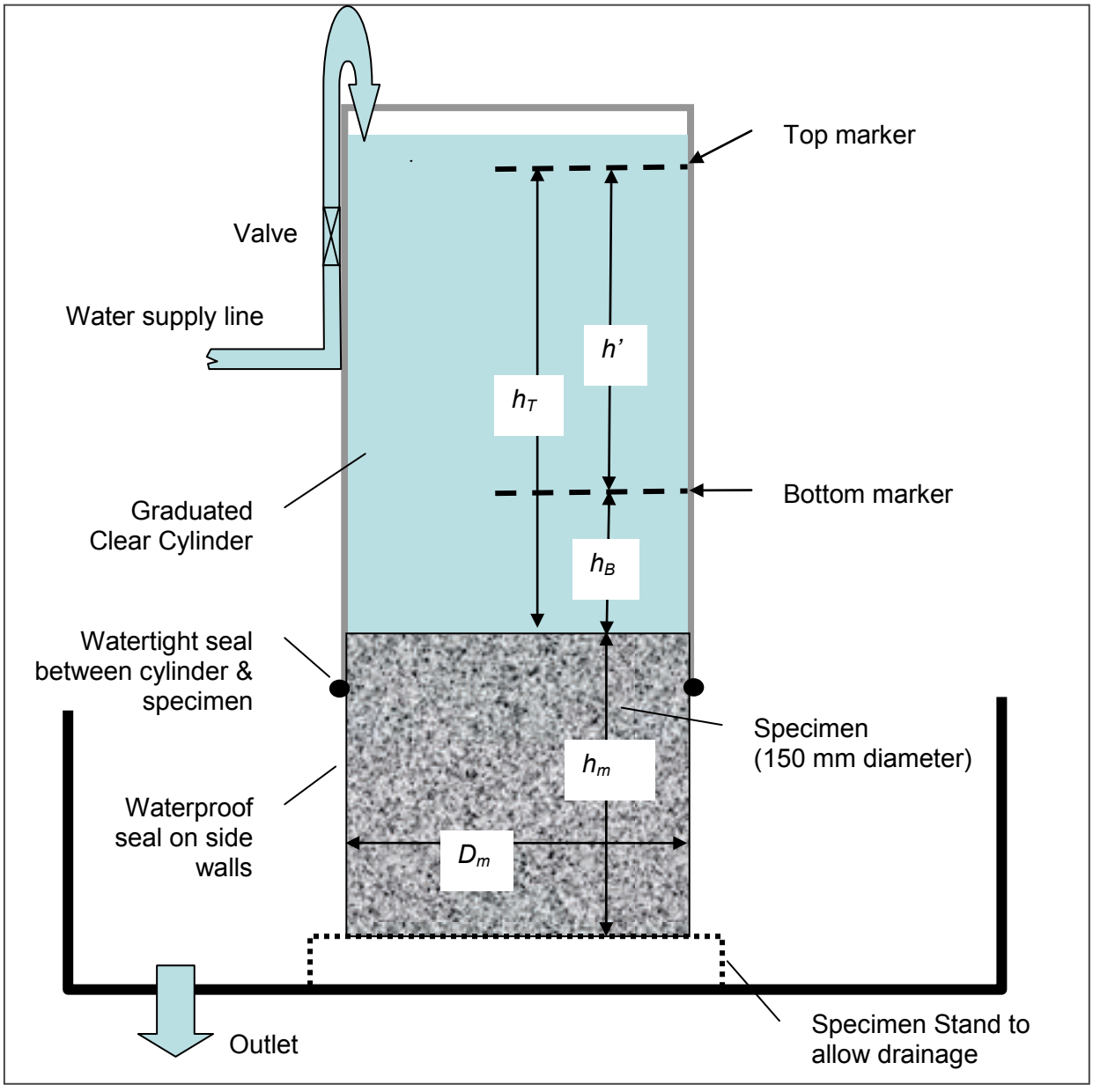

Figure 1 - Diagram of Laboratory Permeameter with Specimen

(f) Mark the bottom marker on the cylinder to give a timing of at least 6 s for the water level dropping from the top to the bottom marker of the cylinder.

NOTE: The bottom marker can be adjusted following the first time measurement

5.2 Permeability Test

(a) Measure the height of the top mark above the surface of the specimen (h_T) and height of the bottom mark above the surface of the specimen (h_B).

(b) Gradually fill the cylinder with water to the upper marker on the cylinder and stop the inflow. Check that the water temperature of the source is between 15 to 25°C and that there is no water leaking from around the specimen.

(c) Open the water supply line to allow the water to run through the specimen so that the water level in the cylinder is kept just above the top marker.

(d) Keep water running through for at least 1 min. Ensure the water passing through the specimen drains through to the underside and that sufficient outlet drainage is provided to ensure the specimen does not stand in water for the duration of the test (refer to Figure 2).

(e) Quickly stop the water from entering the cylinder (refer to Figure 3). Using the timing device, measure the time (ti) for the water level to fall from the top marker to the bottom marker of the cylinder (refer to Figure 4).

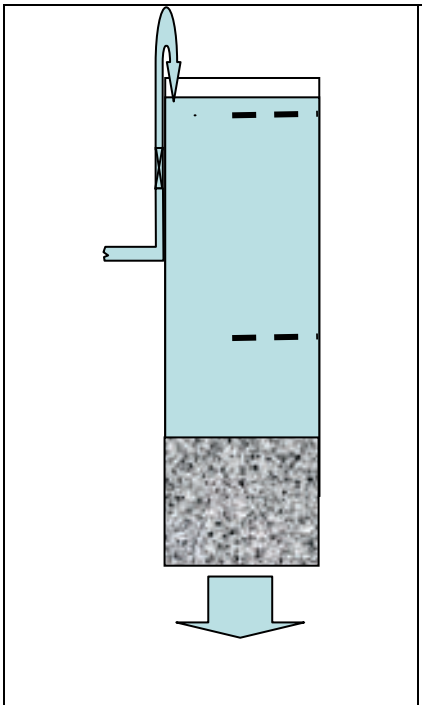

Figure 2 - Water is allowed to surcharge through the specimen.

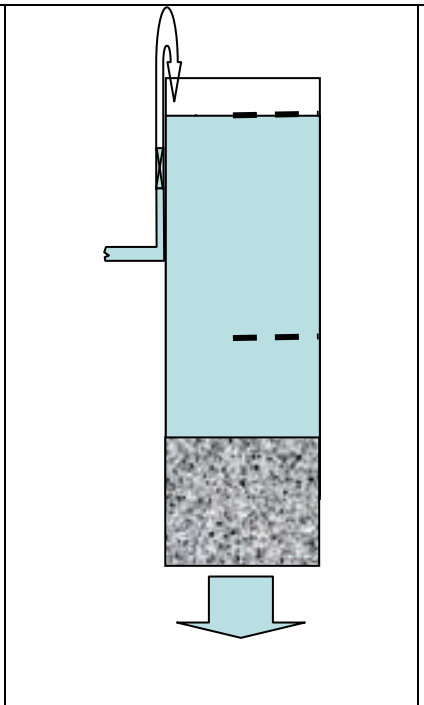

Figure 3 - Water is stopped and timing begins when level with the top marker.

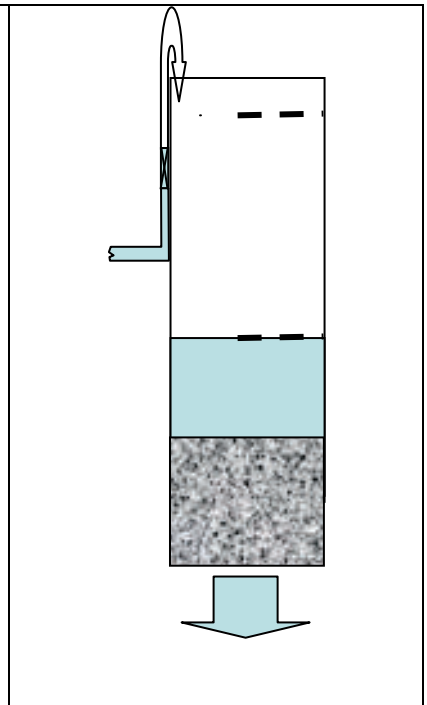

Figure 4 - Timing recorded when water level with bottom marker.

(f) For the first time measurement, if the measured time is less than 6 s, separate the bottom marker further apart and redo from Step 5.2.

NOTE: The required separation can be estimated by (6 / t) x h'.

(g) Repeat the time measurement in Steps 5.2(b) to (e) for a total of 3 time measurements.

(h) If the range in 3 time measurements is more than 0.5 sec, delete the readings and repeat Step 5.2.

(i) Remove the cylinder from the specimen.

NOTE: The specimen may be required for other tests.

6. CALCULATIONS

(a) Where a specimen has a known cross-section determined from T378, proceed to the next Step. Otherwise, calculate the cross-sectional area of the specimen (A) using the formula:

$$A = \left(\frac{\pi D_m^2}{4}\right) \times 10^{-6} \quad \ldots. 6(1)$$

Where:

A = Cross-sectional area of the specimen (m^2)

D_m = Average diameter of specimen (mm)

(b) Calculate the average of three time measurements (t) to the nearest 0.1 s

(c) Calculate the volume between the markers of the cylinder using the formula:

$$V_C = \left(\frac{\pi D^2 h'}{4}\right) \times 10^{-9} \quad \ldots. 6(2)$$

Where:

V_C = Volume of water in cylinder (m^3)

D = Internal diameter of cylinder (mm)

h' = Height between markers on the cylinder (mm)

(d) Calculate the flow rate using the formula:

$$F = \frac{V_C}{t} \quad \ldots. 6(3)$$

Where:

F = Flow rate (m^3/s)

V_C = Volume of water in cylinder (m^3)

t = Average time for water to fall between markers on the cylinder (s)

(e) Calculate the hydraulic gradient using the formula:

$$i = 1 + \left(\frac{h_T + h_B}{2h_m} \right) \ldots. 6(4)$$

Where:

i = Hydraulic gradient

h_T = Height of the top mark above the surface of the specimen (mm)

h_B = Height of the bottom mark above the surface of the specimen (mm)

h_m = Average height of specimen (mm)

(f) Calculate the permeability using the formula:

$$k = \frac{F}{A \times i} \ldots. 6(5)$$

Where:

k = Permeability (m/s)

F = Flow rate (m^3/s)

A = Cross-sectional area of the specimen (m^2)

i = Hydraulic gradient

7. REPORTING

Include the following information and results in the report:

(a) Source of the specimen (i.e. core or moulded specimen):

i) Where the specimen is a core, the location as chainage and lateral offset

ii) Where the specimen is prepared in a laboratory, the mix, compaction details and curing period in days

(b) Age of the sample in days.

(c) Diameter (D_m) and height (h_m) of specimen to the nearest 1 mm.

(d) Average time for water to discharge (t) to the nearest 0.1 s.

(e) Hydraulic gradient (i) to two decimal places.

(f) Permeability (k) in m/s in scientific notation to two significant figures.

(g) Photographs of the top and bottom of the sample, and three photographs of the side of the sample taken at least 90° apart.

(h) Reference to this test method.

http://www.rms.nsw.gov.au/business-industry/partners-suppliers/specifications/volume-1-materials-test-methods.html

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Customer feedback
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