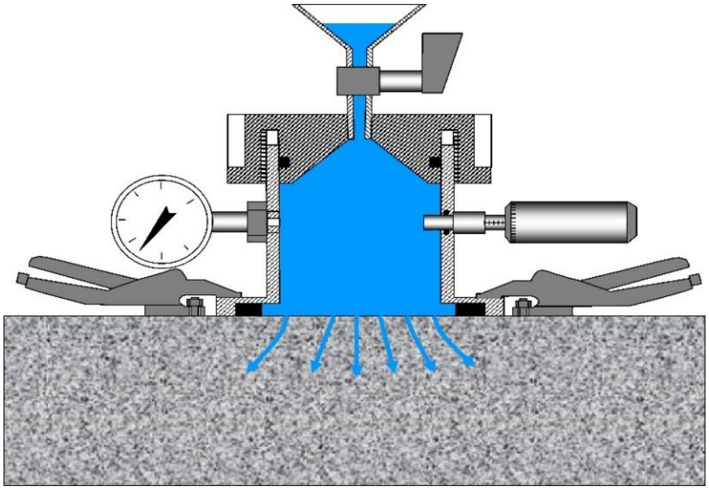
Purpose

The **GWT** (**G**ermann **W**ater permeation **T**est) is used for on-site evaluation of

- Water permeation of the skin-concrete in finished structure
- Water permeation of masonry panels
- Water tightness of construction joints and sealed control joints
- Effectiveness of waterproofing admixtures, additives, membranes, coatings or other surface applied compounds
- Approximate estimation of the coefficient of water permeability of concrete or other material alike by the penetration method

Principle

The **GWT** measures the permeation of water into the test surface under an applied pressure.



A pressure chamber containing a watertight gasket is secured tightly to the surface by two anchored clamping pliers or by means of a suction plate. Alternatively, the gasket may be bonded to the surface with a proper sealant.

The chamber is filled with water and the water is allowed to be absorbed by the test surface for a certain time (from 10 minutes to several hours depending on the purpose of the test). The filling valve is closed, and the top cap of the chamber is turned until a desired water pressure is displayed on the gauge. As water permeates into the concrete, the selected pressure is maintained by means of a micrometer gauge pushing a piston into the chamber. The piston movement compensates for the volume of water penetrating into the material.

The travel of the piston as a function time is recorded and the speed the piston travel in µm/s is used to characterize the permeation of the test surface.

Application Examples

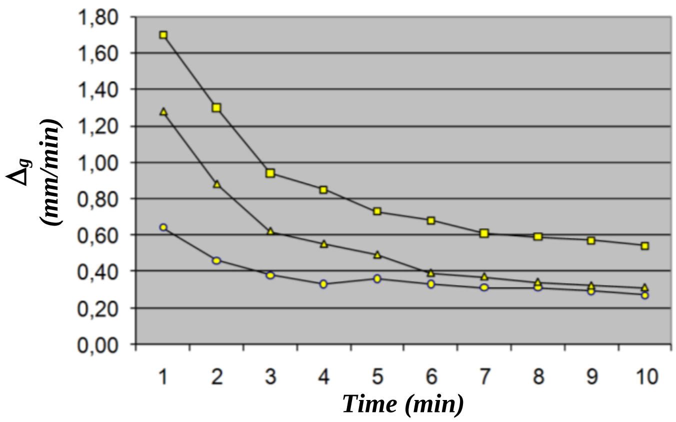
1. Permeation of Concrete Surface

On the left, the cap of the **GWT** is being tightened to bring the water pressure to 1 bar (100 kPa). On the right the **GWT** is being used on a vertical concrete surface. An elbow is used to permit initial filling of the chamber. The micrometer is turned to advance the piston and maintain the water pressure constant at 1 bar (100 kPa). The micrometer position is recorded as a function of time as a qualitative parameter to characterize the velocity of water penetration.

$$\Delta_g = g_n - g_{n+1} \qquad (1)$$

where
Δ_g = speed of the micrometer piston travel (mm/min)
g_n = the micrometer gauge reading after n minutes of testing (mm)
g_{n+1} = the micrometer gauge reading after n+1 minutes of testing (mm)

When Δ_g is plotted over the testing time, the curves are a good guide to compare the performance of different surfaces. The figure below shows curves for 3 different concretes during 10 minutes of test, which is usually a good duration for a quick test.

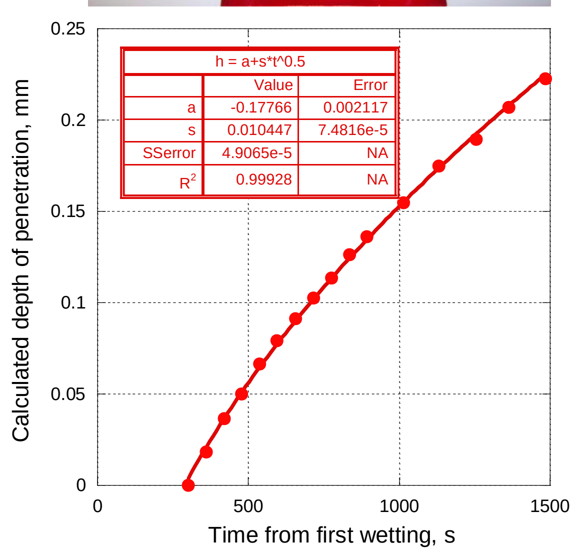


2. Laboratory Evaluations

With the use of the optional laboratory kit a set of extension rods, clamps and bench, the **GWT** can be used to determine the water penetration characteristics of specimens of alternative concrete mixtures. While a standard method for evaluating test data exists, one approach is to calculate the "depth" of water penetration as a function of time using the following relationship:

$$h(t) = \left(\frac{d}{D}\right)^2 (g_1 - g_2(t)) \qquad (2)$$

where
$h(t)$ = depth of water penetration at time t, mm
d = diameter of micrometer piston, 10 mm,
D = inside diameter of gasket, 62 mm,
g_1 = initial micrometer gauge reading at start of measurement, mm, and
$g_2(t)$ = final micrometer gauge reading at time t, mm.



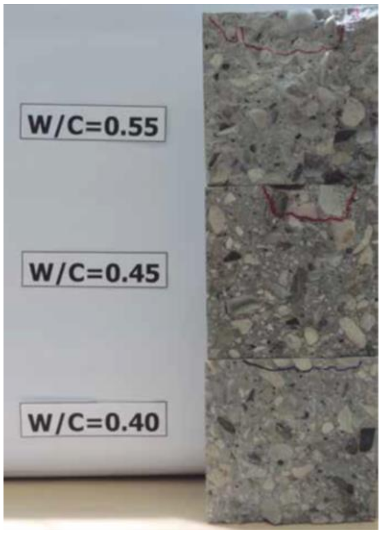
It has been found that the depth of water penetration is a linear function of the square root of time [1], where time is measured from when water is first added to the GWT chamber. Therefore, the following function can be fitted to the data:

$$h(t) = a + s\sqrt{t} \qquad (3)$$

where a is the intercept and s is called the **sorptivity index** in units of mm/$t^{0.5}$. The plot to the right is an example of typical data of depth of water penetration versus time. In this case, measurement of water penetration began after a 5-minute delay from the time water was introduced into the chamber. The chamber pressure was 1 bar (100 kPa). The best-fit of Eq. (3) is shown, and the sorptivity index from the regression analysis is 0.01 $mms^{0.5}$.

3. In-place Quality Assurance Testing

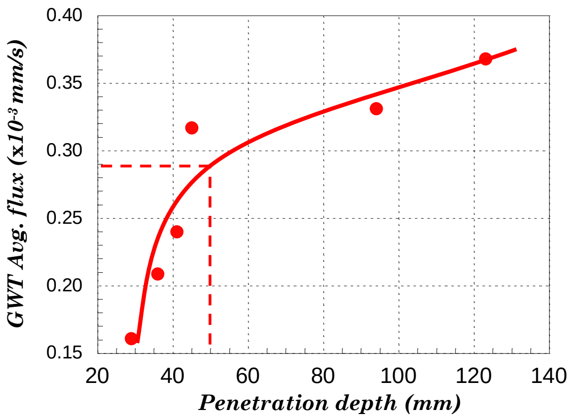
In the standard EN 12390-8 "Testing Hardened Concrete-Part 8: Depth of Penetration of Water Under Pressure", the depth of water penetration is measured on companion specimens. This method requires the specimens to be taken to the compression machine to split it transversally into two halves (Brazilian test) and the depth of penetration, indicated by the moisture stain, is visually measured. The figure on the right shows an example of three split specimens after being tested. The moisture stain was marked to compare the difference in water penetration depth after 72 hours of exposure to 5 bar. Project specifications often require that the concrete meets a maximum water penetration using this test.



For quicker permeability assessments, correlations can be established between the average flux of water measured by the GWT in a given short time and the depth of water penetration measured on companion specimens using the described EN 12390-8. The next graph is an example of such a correlation by testing 6 different mixes [3]. For example, a maximum depth of 50 mm is specified typically for concrete in non-corrosive conditions. Using the established correlation, the GWT can be used for in-place testing to demonstrate that the concrete in the structure conforms to the water penetration requirements.

Specimen	f'c (MPa)	Avg. penetration depth (mm)	GWT Avg. flux* ($x10^{-3}$ mm/s)
1	57.0	29	0.161
2	38.5	94	0.331
3	43.3	41	0.240
4	56.4	36	0.209
5	45.9	45	0.317
6	37.9	123	0.368

**10 minutes at 1 bar. Correlations curves for different testing times and applied pressures may be obtained.*



4. Masonry Permeability

The GWT is shown being used for testing the water tightness of a brick masonry wall. It was found that when it rained and for a normal wind pressure, water penetrated the wall. The first thought was that there was a problem with the mortar joints. By using the GWT, however, the problem was shown to be related to the brick units, not to the mortar joints. The brick units had been burned at a higher temperature than normal to produce the required color, but the higher burning temperature increased the permeability of the brick.

GWT Features and Specifications

- Lightweight, handheld equipment, easy to operate in the lab and in-situ
- Strong aluminum/stainless steel chamber
- Kit includes 2 pressure gauges
- 4 bar (400 kPa) maximum pressure
- High precision micrometer for registering water volume
- 2 types of watertight gaskets for different surface conditions

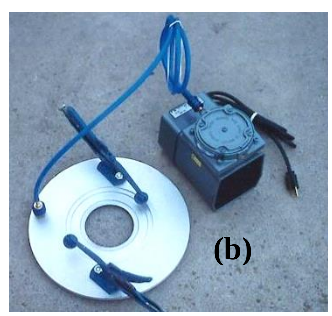
GWT-4000 Kit Ordering Numbers

Item	Order #
Pressure chamber unit with 0-1.5 bar* gauge and micrometer	GWT-4010
Wrench for pressure lid	GWT-4020
Extra 0 - 6 bar gauge	GWT-4030
Water filling cup with L-joint	GWT-4050
Adjustable clamping pliers	GWT-4060
Set of anchoring tools	GWT-4080
Wrenches: 14 and 17 mm	GWT-4090
Sealant tape	GWT-4100
Bottles with boiled water, 3	GWT-4110
Foam gaskets, 15 mm thick, 4	GWT-4130
Rubber gaskets, 15 mm thick, 3	GWT-4131
Manual	GWT-4140
Attaché case	GWT-4150

*1 bar = 100 kPa

Optional Items:

Item	Order #
Laboratory Kit **(a)**. Set of extension rods, clamps and bench for testing on 150 x 300 mm or 100 x 200 mm cylinders, and on 150 mm cubes	GWT-4260
Suction plate & vacuum pump **(b)** for testing without anchoring	GWT-4230
Hammer drill machine	GWT-4240



References

[1] Mohammadi, B and Nokken, M.R., "Influence of Moisture Content on Water Absorption in Concrete," 3rd Specialty Conference on Material Engineering & Applied Mechanics, Montreal, May 29-June 1, 2013.

[2] Valenta O. (1970) "The permeability and durability of concrete in aggressive conditions". Proceedings of 10th International Congress on Large Dams, Montreal.

[3] Moczko Andrzej, Moczko Marta. GWT – "Testing System for "in-situ" Measurements of Concrete Water Permeability", Wrocław University of Technology, Poland, 2015.