Experiment 16

Surface Water Permeability (RILEM Test Method 11.4)

Updated 7.17.2024

Purpose

To measure the volume of water absorbed by bricks within a specified time period. This procedure may be applied to a variety of materials; in the laboratory, or in-situ; to determine the water permeability of masonry materials, changes in permeability from weathering, or the effectiveness of a water repellant or consolidation before and after treatment.

Additionally, the test can be performed perpendicular and parallel to orientation (e.g., bedding planes of a stone), on the interior or weathered surface, or on a treated and untreated surface.

Principles

Masonry building materials are porous, thus they are all somewhat permeable to water. Moisture is a precondition for most processes of deterioration: water present within the interconnected pore structure of the interior of masonry materials can cause damage through freeze/thaw cycling. Pollutant gases and salts are harmful when dissolved in water, and moisture is also a requirement for biological growth and decay. Water permeability of a masonry material is directly related to its durability.

The apparatus used in this procedure can be applied in two forms:

1. Vertical surfaces, simulating the action of wind-driven rain (Figure 1)
2. Horizontal surfaces, simulating ground water entering the base of a structure or from above such as from falling rain or leaking gutters (Figure 2).

The total height of the column of water applied by the apparatus is 9.8 cm (or relative to it, as is the tube intended for concrete application), corresponding to a pressure of 961.38 Pa (0.14 psi), or a dynamic wind pressure of 142.6 km / hour (88.5 mph).

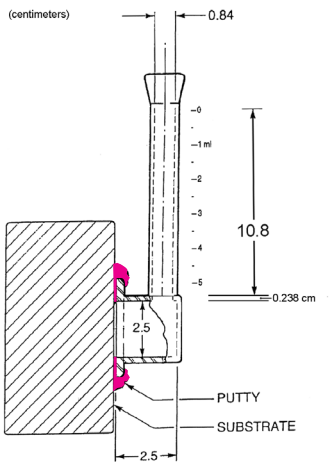

Figure 1: Vertical application. Observe putty does not obstruct water flow.

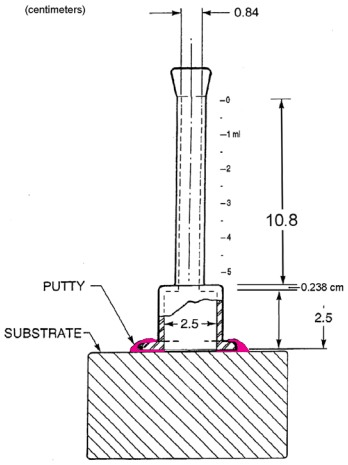

Figure 2: Horizontal application

Methodology

The areas to be tested *in situ* should be representative of the wall or building under evaluation. Conditions regarding temperature, humidity, weather, and light conditions should be recorded. In the laboratory, the specimen should best represent the condition being evaluated, whether it is weathering, presence of hygroscopic salts, soiled samples, or applied treatments like water repellants. This test should not be performed in high humidity (above 60% RH) or after recent wet or damp weather.

By comparing data obtained on the test sample against data obtained on a control sample (e.g. an unweathered, untreated, clean, and representative specimen) the degree to which water permeability is affected may be measured.

Equipment

2 RILEM induction tubes for vertical and horizontal application
1 RILEM putty or weatherstripping caulk
1 chronometer
1 #2 pencil
1 impermeable surface (glass drying tray)

Samples

- low-fired brick
- high-fired brick

Reagants

- deionized water

1.0 Preparation

The sample must be dry.

1.1. Observe and record whether the sample has been treated; if the surface is weathered or unweathered (in cross section), and orientation (compaction marks, if present) or other features such as a fire skin in ceramics.

1.2. Note the observed conditions, temperature, and humidity on Table 1. These factors, as well as how long the sample had remained in those particular conditions, the availability of sunlight and water, and other variables will have an effect on the results.

2.0 RILEM Test

As a control experiment, apply an horizontal RILEM tube on the inside base of a large Pyrex dish. This will help monitor evaporation as an external factor affecting results.

2.3. Choose a surface upon which to apply the induction tube. Avoid visible surface cracks. Record the test location on the sample with a #2 pencil.

2.4. Apply a small strip of hand-warmed putty to the brim of the induction tube. Be careful not to obstruct the tube opening as this will affect the water flow rate and subsequent calculations (Figure 1).

2.5. Press firmly against the surface of the brick sample continually checking for obstruction.[1] At this point, the sample must not be moved until testing is complete.

2.6. Slowly add deionized water to the tube until the bottom of the meniscus of the column of water reaches the 0 gradation mark. Gently squeeze the wash bottle to dispense the water along the inner wall of the tube in order to reduce the occurrence of trapped air bubbles (which can affect the results of the test).

2.7. Start the timer as soon as the meniscus reaches 0.

2.8. Measure and record the amount of water absorbed at the following intervals: 0, 5, 10, 15, 20, 30, and 60 minutes and every following hour if water remains at measurable intervals.[2] Some stones may need to be measured at shorter intervals depending on their permeability.

2.9. Repeat steps 2.1-2.6 on the second brick.

2.10. Present the results of all test measurements in the form of a water absorption graph, where water absorption (cm^3) is a function of time (minutes). Include both horizontal and vertical applications on the same graph for each brick.

2.11. Include a photograph of each brick showing the test setup in both horizontal and vertical (Figures 3 and 4) after the test is complete to record any water staining patterns.

[1] In the field, under certain conditions and situations, low-adhesion silicone may be used if the RILEM putty does not stick to the sample surface and if this will not adversely affect the material being tested.

[2] Highly permeable bricks will absorb the 5 mL of water within seconds, so be prepared to record the test using a video camera or phone to get measurements to the milisecond. Revise data points in Table 2 accordingly.

References

Gale, Frances. "Measurement of Water Absorption." *APT Bulletin* Vol. 21 No. 3-4, 1989, pp. 8-9.

RILEM test N° II.4 in "Commission 25-PEM Protection et Érosion des Monuments, Recommended Tests to Measure the Deterioration of Stone and to Assess the Effectiveness of Treatment Methods." *Materials and Structures*, vol. 13, no 75 (1980): 175-253.

http://www.prginc.com/Masonry/rilem_method.html

Data & Observations

	Brick A		Brick B		Control
	Horizontal	Vertical	Horizontal	Vertical	Horizontal
Conditions					N/A
Temp (°C)					
RH (%)					

Table 1: External conditions

Time hh:mm	Brick A		Brick B		Control
	Horizontal	Vertical	Horizontal	Vertical	Horizontal
00:00					
00:05					
00:10					
00:15					
00:20					
00:25					
00:30					
00:35					
00:40					
00:45					
00:50					
00:55					
01:00					
01:30					
02:00					
02:30					
03:00					
04:00					
05:00					
06:00					
24:00					

Table 2: Amount of water absorbed by damp line measurements

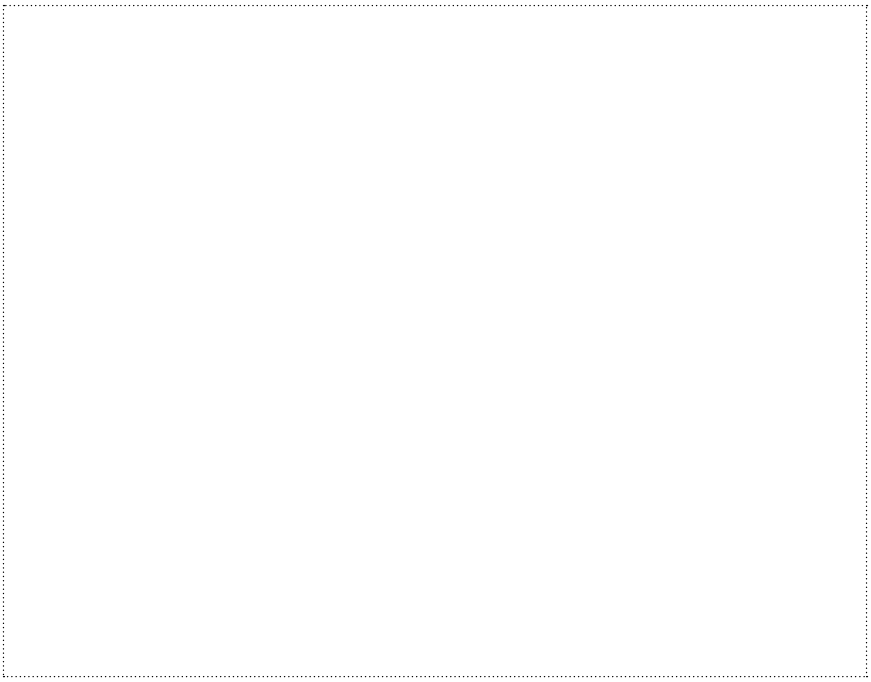

Figure 3: Surface water permeability for Brick A in horizontal and vertical.

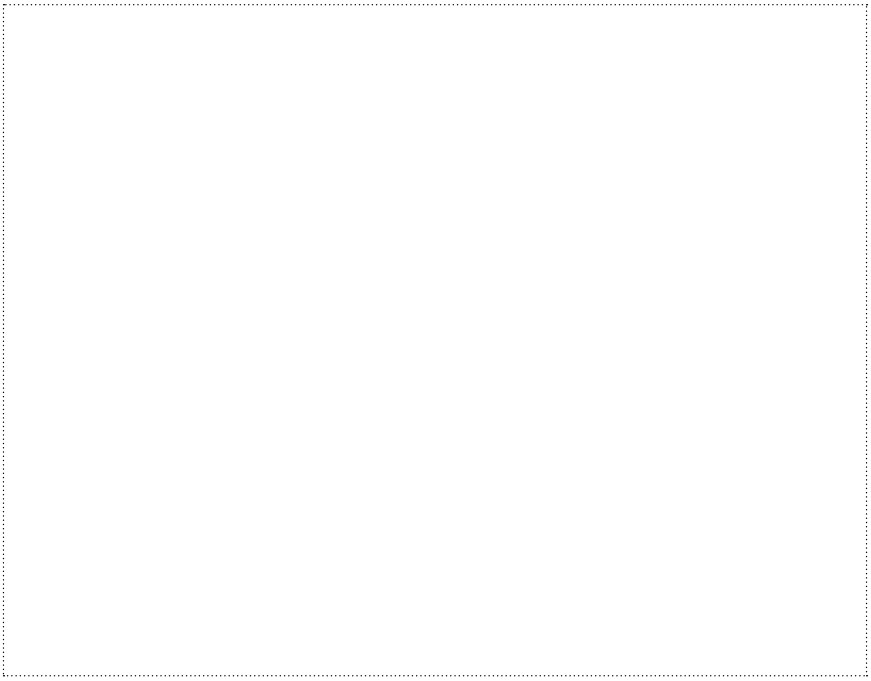

Figure 4: Surface water permeability for Brick B in horizontal and vertical.

Discussion

1. **Was the water absorption the same for different surfaces of a given sample? If not, explain why.**

2. **How might the samples' surface texture affect water absorption?**

3. **What are the possible sources of error?**