MEASUREMENT OF WATER ABSORPTION UNDER LOW PRESSURE

Rilem Test Method - Test No. II.4

Introduction

RILEM (Reunion Internationale des Laboratoires D'essais et de Recherches sur les Materiaux et les Constructions), with headquarters in Paris, is the International Union of Testing and Research Laboratories for Materials and Structures. As with our American Society for Testing and Materials (ASTM), Technical Committees are formed within RILEM to develop standard methods for measuring properties and evaluating the performance and durability of many different building materials.

One such technical committee, Commission 25-PEM, developed tests to measure the deterioration of stone and to assess the effectiveness of treatment methods. The standard tests drafted by Commission 25-PEM fall within several categories, including methods for determining internal cohesion (III.), for measuring mechanical surface properties (IV.), and for detecting the presence and movement of water (II.). Within category II., is Test Method No. II.4, designed to measure the quantity of water absorbed by the surface of a masonry material over a definite period of time.

RILEM Test Method II.4 provides a simple means for measuring the rate at which water moves through porous materials such as masonry. The test can be performed at the site or in the laboratory and can be used to measure vertical or horizontal water transport. Water permeability measurements obtained in the laboratory can be used to characterize unweathered, untreated masonry. Measurements made at the site (or on samples removed for laboratory testing) can be used to assess the degree of change due to weathering that the material has undergone. Test Method II.4 can also be used to show a level of change in surface porosity delivered by a water-repellent treatment. A description of the equipment and procedure for conducting this test is provided in paragraphs below.

Theory

Because masonry building materials are porous, they are all somewhat permeable to water. The internal structure of a masonry material is a system of fine interconnected pores. Wetting by liquid water involves capillary conduction (suction) through this pore system, proceeding along both vertical and horizontal pathways. Moisture transport occurs when water in soils enter at the base of a structure or as rainwater through leaking gutters or rain on wall surfaces. (Under actual conditions, the amount of rain penetration depends on various conditions as well as on the composition and condition of the exposed surface.)

When liquid water comes into contact with a masonry surface, wetting proceeds through the material as a front. Accurate measurements of the advance of this wetting front made on a variety of masonry building materials have demonstrated that the characteristic wetting rate and pattern of each material are directly related to it capillary structure and port size distribution. In fact, rate constants have been measured for brick, limestone and other masonry materials. RILEM Test Method II.4 provides a simple method for measuring the volume of water absorbed by a material within a specified time period.

Equipment

The equipment necessary for measuring water absorption under low pressure is simple. The test can be performed at the site or in the laboratory with a test apparatus available in two forms. One is designed for application to vertical surfaces and measures horizontal transport of water. A second form is designed for application to horizontal surfaces and measures vertical transport.

Figure 1 illustrates the pipe-like apparatus designed for vertical surfaces. Its flat, circular brim (at the bottom end of the pipe) is affixed to the masonry surface by interposing a piece of putty. The open, bottom end of the pipe has an area of 4.9 cm^2. The vertical tube is graduated from 0 to 5 mL with each gradation representing an increment of 0.5 mL (It is therefore possible to estimate to 0.25 mL). The total height of the column of water applied to the surface, measured from the center point of the flat, circular brim to the topmost gradation, is 12 cm.

The apparatus designed for application to horizontal surfaces, similar to the one for vertical surfaces described above, is illustrated in Figure 2. The horizontal tube is graduated in the same way as the vertical tube. The total height of the column of water applied to the surface, measures from the flat, circular brim to the topmost gradation, is 13.4 cm.

Procedure

The testing apparatus is affixed by interposing a tape of putty between the flat, circular brim of the pipe and the surface of the masonry material. To ensure adhesion, manual pressure is exerted on the cylinder. Water is then added through the upper, open end of the pipe until the column reaches the "0" gradation mark. The quantity of water absorbed by the material during a specified period of time is read directly from the graduated tube. The periods of time appropriate for the test depend on the porosity of the material on which the measurement is being made; generally 5, 10, 15, 20, 30 and 60-minute intervals provide the most useful data. In many cases, it may be important to measure water absorption through the mortar joint as well as the surface of the brick (or natural stone) substrate.

Report

Results of the test measurements are presented in the form of a water absorption graph with the volume of water absorbed in milliliters reported as a function of time in minutes. The masonry surface tested must be mentioned in the report.

Applications

NEW CONSTRUCTION

Water has long been associated with deterioration processes affecting masonry materials. Its presence within the interior pore structure of masonry can result in physical destruction if the material undergoes wet/dry or freeze/thaw cycling. The latter is particularly damaging if the masonry material has a high clay mineral content. Perhaps of greater importance is the fact that the presence of moisture is a necessary precondition for many deterioration processes. Pollutant gasses are harmful when they are dissolved in water; fluorescence phenomena are dependent on the migration of salts dissolved in water; moisture is a requirement for the growth of biological organisms. Because of these factors, the water permeability of a masonry material can be related to its durability. Thus, results obtained using Test Method II.4 can be used to predict potential vulnerability of untreated, un-weathered masonry materials to water-related deterioration.

RILEM Test Method II.4 can be used to evaluate the performance of a water repellent treatment. A comparison of test results obtained on treated masonry samples with those obtained on untreated samples provides information about the degree of porosity reduction provided by the water repellent treatment.

EXISTING CONSTRUCTION

Test Method II.4 also provides useful information when carried out on weathered masonry surfaces. Water permeability of a material is affected when its surface is obscured by the presence of atmospheric soiling or biological growth, or when there are hygroscopic salts within the interior. The formation of a weathering crust due to mineralogical changes occurring on the exposed (weathered) surface may substantially affect water permeability measurements. By comparing data obtained on masonry that has been exposed to the elements with measurements made on un-weathered samples, it is possible to measure the degree of change that has occurred in surface porosity.

TYPICAL USE OF RILEM TUBES – COMPARATIVE TESTING

The best use for a Rilem tube would be for comparative measurements such as (1) before and after surface treatments, (2) comparing surface porosity at an area with interior moisture problems compared to an area without interior moisture problems, (3) comparing an area with surface efflorescence to a similar surface without efflorescence, (4) comparing porosity of building units to the porosity of the mortar joints, etc.

Note: A Rilem tube is used to provide a measurement related to the porosity/moisture absorption of a material and/or its surface. The measurement achieved by this process does not indicate a positive or negative condition but rather the rate of absorption at a specific location. Material that easily absorbs moisture typically allows for easy desorption. If rapid moisture absorption were a negative, none of the low fired soft brick structures with arcane lime mortars would still be standing. The viability and possible deterioration of a material is a more complex process and well beyond the simple fact of available moisture. In historic preservation, the Rilem test is typically used to show that surface porosity is not the problem.

(1) If it is determined that a treatment to reduce surface absorption is beneficial then a Rilem test before and after the surface treatment would indicate a relative differential measurement related to surface absorption.

(2) When surface porosity is being considered a possible source of interior moisture problems, applying the Rilem test method on the exterior surface of the related problem area provides a standard for testing other similar surfaces to determine if the problem area has a greater porosity. The Rilem test should be applied to exterior locations on the same building - on the same elevation exposure, with the same material, etc. - trying to match all of the same conditions as the problem area with the exception of no interior moisture problems. If the surface porosity measurements of the areas with no interior problem matches or are similar to the surface measurement of the problem area, it is a likely assumption that surface porosity is not the problem.

(3) When efflorescence is visible on the surface of the masonry material, it typically indicates that moisture has been traveling through the masonry substrate picking up soluble salts along the way and then depositing them on the surface where evaporation of moisture occurs. Visible surface efflorescence typically does not occur where the absorption condition is strictly a surface process. Not enough soluble salts are available within that absorption / desorption zone for efflorescence to accumulate. The area of efflorescence should be cleaned of the crystalline contamination in order for the Rilem adhesive to be able to secure the tube appropriately to the surface. Once that is achieved, a comparison of the absorption measurement at the efflorescence area compared to a non-efflorescence area can be undertaken. The existing elevated salt content in an area of efflorescence may increase water absorption in the surface and may also cause a visible ring of moisture to spread out from around the area where the Rilem tube is in contact with the wall.

(4) The traditional logic of building a masonry wall is that the mortar joints are more porous than the building units, i.e.: bricks, blocks, stone, etc. If a masonry wall has been re-pointed with a mortar that is harder and allows less moisture to migrate through it then the path of least resistance becomes the building units themselves. In these situations the surfaces of the bricks (or other masonry units) can be seen to deteriorate leaving the mortar joint proud (extending beyond the deteriorated surface of the masonry units). Using the Rilem test for measuring the surface porosity of the building units compared to the surface porosity of the mortar joint would be an appropriate application when these conditions are observed. This test may also be appropriate on proposed mortars prior to approving materials for a re-pointing project.

References

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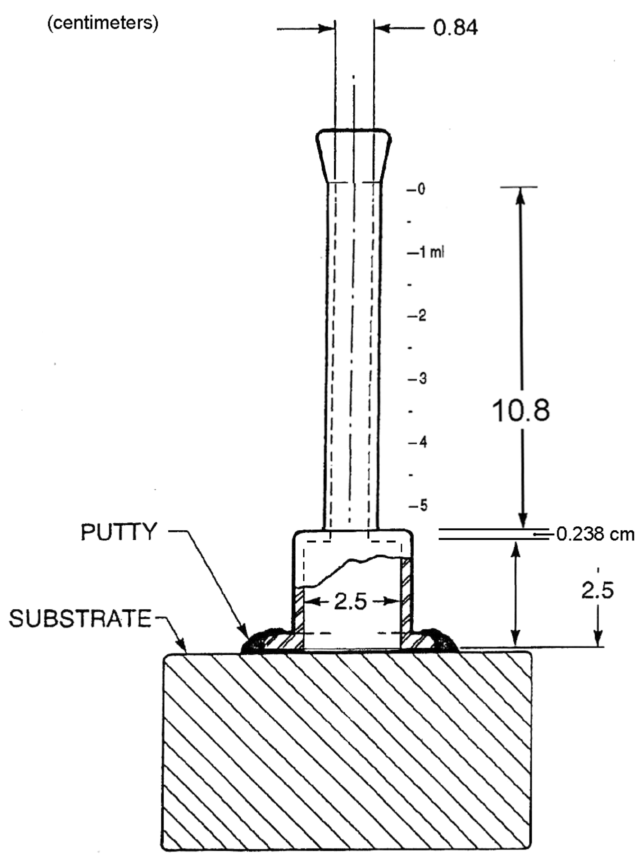
Rilem Test Method No. 11.4
Horizontal Application



Rilem Test Method No. 11.4
Vertical Application