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MEASURING WATER PERMEABILITY OF MASONRY WALLS

By

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13. ABSTRACT

The Dunwell procedure for determining the water permeability of masonry walls was modified so that it improved reproducibility, decreased the testing time from 3 to 4 days to less than one hour and did not mar the painted surface. These improvements resulted from the elimination of the possibility of air entrapment in the reservoir and finding a sealant that produces a leak-free system immediately and could be washed off with common solvents.

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INTRODUCTION

For the past several years the Materials Testing Laboratory, operated by the Officer in Charge of Construction, Mid Pacific, has been using a test procedure that measures the rate of water transmission through masonry walls. The testing procedure was developed by Francis A. Dunwell, a former Head of that Laboratory, in response to a finding in 1965 that after a driving rain "a heavy volume of water passed through the blocks, loosened interior coatings and collected on the floors" in "recently-painted concrete block walls of new housing units in Kaneohe and Wahiawa on Oahu"[1].

BACKGROUND

Dunwell made a study of the variables associated with excessive water permeation of block walls. The most significant controllable variables were determined to be the exterior coating system and its method of application. Examination of the coating with a low power lens revealed "pin-holes" in the coating and the relative ease of water transmission through the walls was directly proportional to the number of these pin holes.

A standard was established limiting the number of pinholes. Counting pin holes in a coating is, however, a time consuming and boring job. It was also difficult to convince the painting subcontractors of the significance of pin holes. As a result they protested vigorously that they could not meet the standards based on these counts at a reasonable cost.

Dunwell then developed a procedure which consisted of applying a cylinder of water to a masonry surface and measuring the rate of disappearance of water into that surface. When the rate of disappearance was less than 1 gallon/square foot/hour there were no damaging effects. When the rate exceeded this figure the damaging effects described earlier were produced. In order to provide a margin of safety and because it was feasible to do so, an upper limit of 1/2 gal/ft^2/hr was established. A properly coated surface will have a water transmission rate of about one-tenth that amount.

A satisfactory coating system, when properly applied, and which is being used in Hawaii, consists of a styrene-butadiene fillcoat conforming

[[1]Navy Civil Engineer, Jan 1970, p. 8] to Federal Spec. TT-F-1098 followed by a styrene-acrylate topcoat conforming to Federal Spec. TT-P-1181. The phrase "properly applied" was included because satisfactory results are obtained only when care is used to apply the fillcoat. Merely rolling the fillcoat onto the masonry wall is not sufficient. If it is rolled on, it must also be "fanned out" by brush or it can be applied by brush directly. In either case it is important to fill the surface voids as thoroughly as possible. The Dunwell Test Procedure differentiates between a properly and improperly applied fillcoat.

EQUIPMENT AND MATERIALS FOR DUNWELL PROCEDURE

1. Reservoir: The reservoir was fabricated by sealing a short length of rubber tubing into a hole drilled into an approximately 3 inch diameter paint can lid. (See Figure 1).

2. Adhesive: DAP Butyl Flex®, applied from a calking gun, was used to affix the reservoir to a wall.

3. Burette: 25 ml., glass

4. Masking tape

EQUIPMENT AND MATERIALS FOR REVISED PROCEDURE

1. Reservoir: The reservoir was fabricated by sealing a 3/4 inch length of 3-1/2 inch diameter vinyl tubing with a 1/8 inch wall thickness to a square 1/8 inch thick acrylic plate. Two holes were drilled into the tubing near each other and plastic tubes sealed to these holes. (See Figure 2.)

2. Sealant: DAP® rope caulk

3. Tape: Strong tape containing longitudinal glass fibers

4. Tension Spring: 20 gauge, 5/16 OD, 5 inches long (Lane #315)

5. Pressure transmitter: Dowel or wooden block 2" long

6. Burette: 25 ml, glass

7. Corks: No. 000

DUNWELL PROCEDURE

The Dunwell procedure has undergone a number of minor modifications since its first inception. The following description reports the procedure used by Ray Goo, OICC MIDPAC Materials Testing Laboratory in February 1971.

A spot was chosen on the wall that would accommodate all of the test equipment. The reservoir was held to the wall with one hand and DAP® was applied with a gun to the periphery with the other hand. The DAP® was smoothed with a spatula, held in place with crossed strips of masking tape and allowed to set-up for at least 3-4 days. A 25 ml burette was then attached to the reservoir as shown in Figure 1 and water was introduced into the burette. The entrapped air was removed by repeatedly pressing the center of the reservoir. As the water entered the reservoir more was added to the burette. When the air had all been displaced (5 to 10 minutes) the burette was filled to the zero mark and the time noted. The water was allowed to permeate the wall from the reservoir for 15 minutes or the time required to absorb the 25 ml. From a measurement of the diameter of the reservoir, the rate of water absorption can be expressed in gallons per square foot per hour ($gal/ft^2/hr$). The DAP® is then cut off from the wall with a sharp knife, the residual material is ground off, and the bare spot is repainted.

NCEL PROCEDURE

A ring of DAP® rope is pressed firmly into the open edge of the reservoir which is then pressed firmly to the wall. The DAP® seal is often incomplete and a second ring of DAP® rope is used to reinforce the seal. The reservoir is kept pressed against the wall by a Lane #315 spring stretched between two hooks secured to the wall with the fiberglass filled tape (Figure 2). The DAP® seal is smoothed and worked firmly to make a tight seal. After 5 to 10 minutes, the burette is connected to the inlet tube with a piece of rubber tubing and water is added through the burette. The reservoir fills rapidly, the air being expelled through the exit tube. When the reservoir is full, the exit tube is stoppered and the burette is filled to the zero mark. The water absorbed is measured as before.

FINDINGS

The Dunwell and NCEL test procedures were tested on a wall in a trash enclosure in the Hokolani housing tract. The test is normally applied after the application of the fillcoat but since no such treated wall was available, one coated by the complete painting system was used. The coating system on the test wall was about one year old.

In the Dunwell procedure a wait of at least 3 to 4 days was necessary for the gun-applied DAP® to set up before water could be introduced into the reservoir. In the NCEL modification water could be added within a few minutes after application of the DAP® rope. In both cases about 1.5 ml of water was absorbed by the wall in 15 minutes. Since both reservoirs had approximately the same diameter, each procedure showed an absorption of about 5% of the allowable maximum.

CONCLUSIONS

It can be concluded that either procedure will produce a sufficiently accurate measure of the rate of water permeability through masonry walls. The NCEL procedure, however, has several advantages. These are:

1. Shorter time to get the answer - one hour vs 3 to 5 days.

2. Ensures complete air elimination in the reservoir and therefore more accurate knowledge of the test area. There is no possible air entrapment to alter the test area.

3. More uniform and more rugged reservoir.

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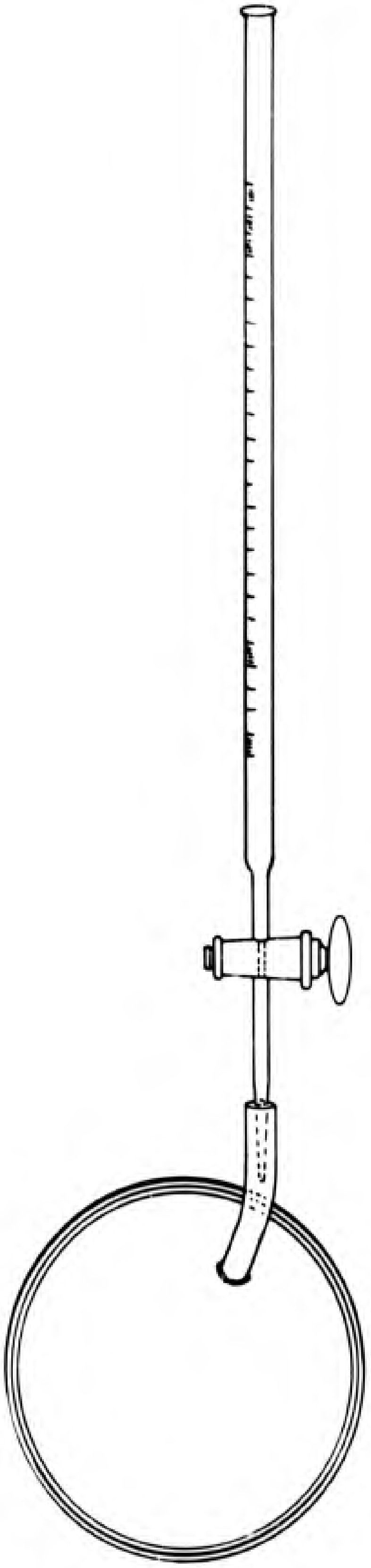

Figure 1

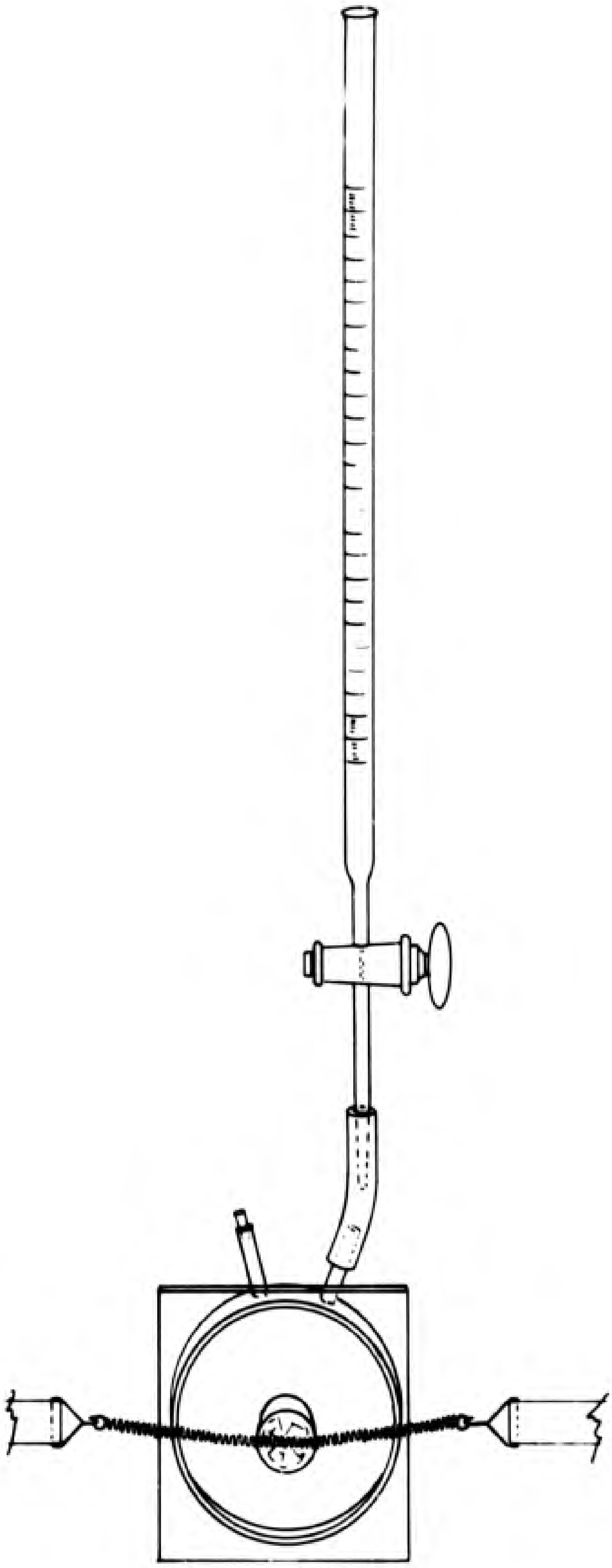

Figure 2

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