Experiment 15

Capillary Rise in Brick

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Purpose

To measure the movement of water in bricks of various methods of manufacture, composition, and age as a function of capillary rise.

Principles

Capillarity, from *capillus*, "hair" in Latin, is the ability of porous and permeable materials to cause liquid to flow through narrow spaces without external forces, such as gravity.

Capillary rise is a very important phenomenon of porous building materials as well as soils. One of the sources of water infiltration into a building is "rising damp," or water from saturated soils in contact with porous building materials. However, liquid water can be directed in all directions, not just vertically. Capillary rise is a type of suction that occurs because the forces of attraction of the water molecules to the material's pore surfaces are greater than the gravitational force. It has been proven that the smaller the diameter of the capillaries, or pores,

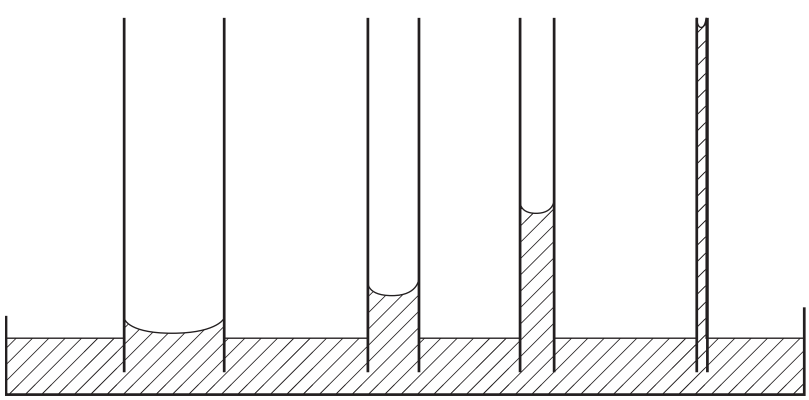

Figure 1: Capillary action. The height of the water is inversely proportional to the radius of the capillary tube.

the greater the capillary force. For architectural ceramics such as brick, tile and terra cotta, these physical properties largely determine durability and are dependent on composition, firing temperature, and production method. The diagnosis of moisture problems as well as decay phenomenon requires an understanding of capillary action on a material.

A simple way to demonstrate capillary rise is to take a series of glass tubes and immerse them in a container of water. The smaller the diameter of the tube, the greater the rise of water will be.

The interconnected series of pores in a building material is known as a capillary network. The diameter of the pores will influence the rise of water differentially within a building material. In Figure 2, C1 has a greater overall diameter than C2. Note how C2 experiences a greater rise than C1.

All materials with an interconnected series of pores have the capability of experiencing capillary rise. Soils are included as the spaces between various grains create a capillary network. Different soil types will be able to conduct water to greater heights than other soils. This phenomenon has important implications when dealing with site conditions for older buildings.

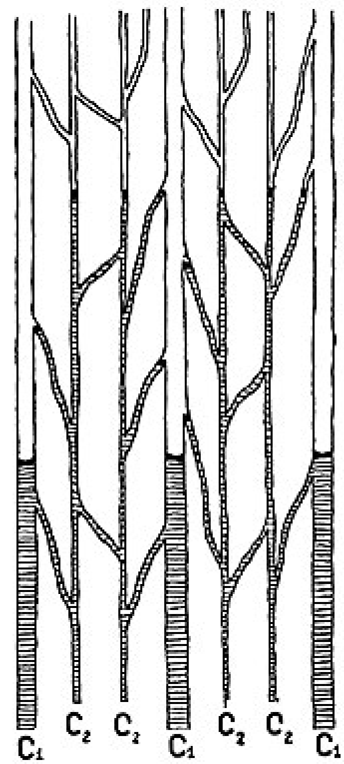

Figure 2.

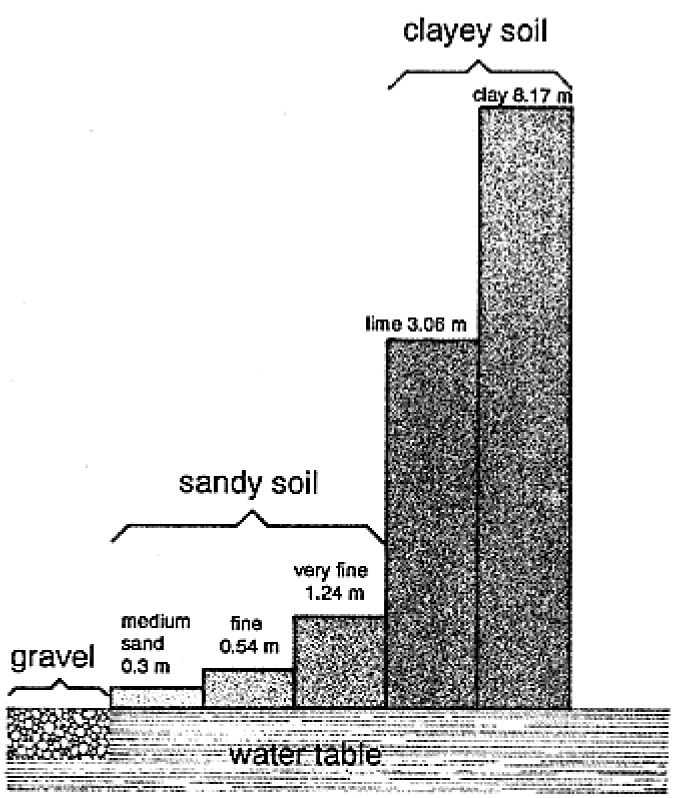

Figure 3: Capillary rise in soils. The height of the water is inversely proportional to the particle size.

Methodology

Equipment

1 glass drying tray
1 edge ruler (not measuring tape)
1 pencil
5+ glass rods

Samples

1 handmade brick and cross section slide
1 machine made brick and cross section slide

Reagants

- deionized water

Procedure

1. Place each brick upright in the glass drying tray, separating the bottom of the brick from the glass surface with glass rods. This will help water access through the bottom, not just the sides.

2. Add deionized water to the tray until 1 cm of the base of the brick is immersed. Mark this baseline with a strong pencil mark. Use the same ruler every time. Make sure that this ruler starts at the end; otherwise, you will have to add an error correction for the space between the edge and the beginning calibration mark.

3. Measure the height (h) of the advancing damp line every minute for the first 5 minutes, then every 5 minutes for the next 25 minutes, then every 30 minutes until the total elapsed time is 180 minutes. Place the ruler next to the brick and record a maximum, median, and minimum height of the damp line on each face of the brick and average these per face.

4. Replenish the water in the container so that the bottom 1 cm of the brick is always in contact with the water.

5. Record the results for each brick sample in Tables 1 and 2. Modify as needed. Insert photos of each brick after completing the experiment.

6. Graph capillary movement over time for each brick.

References

NORMAL 11/85 Capillary Water Absorption and Capillary Absorption Coefficient

RILEM Test No. II 6 Water Absorption Coefficient (Capillarity)

Massari, Giovanni and Ippolito Massari. *Damp Buildings, Old and New*. Rome: ICCROM, 1993. Meng, B. "Characterization of Pore Structure for the Interpretation of Moisture Transport." In *Proceedings of the International Rilem/Unesco Congress "Conservation of Stone and Other Materials--Research-Industry-Media"*, Held at Unesco Headquarters, Paris, with the Cooperation of Iccrom ... [Et Al.], Paris, June 29-July 1, 1993, edited by M. J. Thiel, 155-62. London: E&FN Spon, 1993.

Vos, B. H. "Water Absorption and Drying of Materials." In *The Conservation of Stone I: Proceedings of the International Symposium*, Bologna, 19-21 June 1975, edited by Raffaella Rossi-Manaresi, 679-94. Bologna: Centro per la Conservazione Delle Sculture all'Aperto, 1981.

Data & Observations

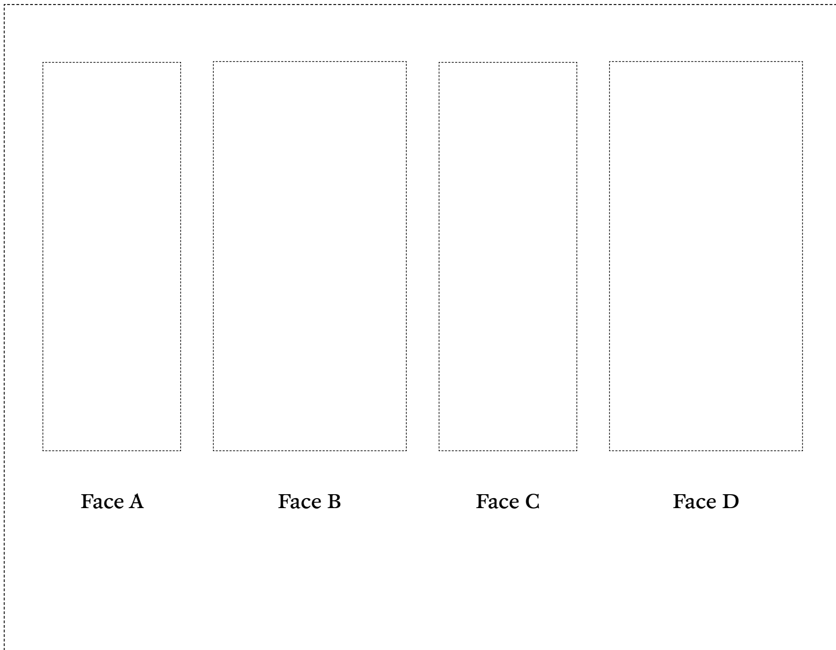

Figure 4: Photograph of Brick A showing all sides

Figure 5: Graph of capillary rise (mm vs square root of time in min)

Time (min)	Height of damp line (mm)			
	Face A	B	C	D
0				
1				
2				
3				
4				
5				
10				
15				
20				
25				
30				
60				
90				
120				
150				
180				

Table 1: Damp line measurements of Brick A.

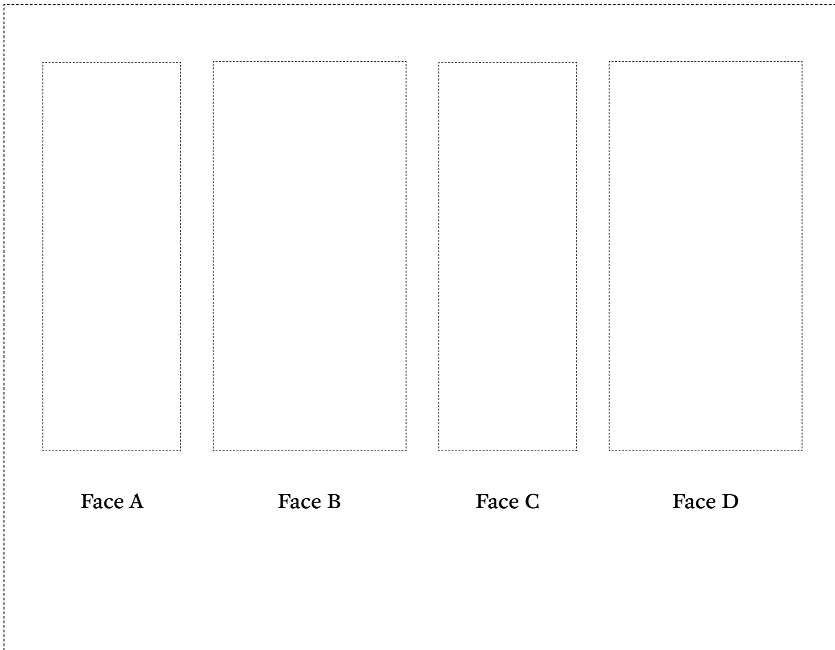

Figure 6: Photograph of brick B

Time (min)	Height of damp line (mm)			
	Face A	B	C	D
0				
1				
2				
3				
4				
5				
10				
15				
20				
25				
30				
60				
90				
120				
150				
180				

Table 2: Damp line measurements of Brick B

Figure 7: Graph of capillary rise (mm vs square root of time in min)

Discussion

1. Are the absorption rates different for each brick the same or different? Why?

2. What might account for the damp profile pattern variances on all faces of each brick?