



PINE HALL BRICK

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Technical Bullet Series on Clay Brick Pavers

#1 - Clay Paver Durability In Harsh Freeze & Thaw Conditions

Abstract – This Technical Bullet details the exceptional durability of clay brick pavers, which is predicted by properties such as absorption, saturation coefficient, compressive strength and break load. It describes the ASTM Standards surrounding these properties and how Pine Hall Brick's clay pavers exceed these Standards. Finally, it demonstrates how Pine Hall Brick's clay pavers perform exceptionally well in the presence of deicing salts.

Durability is defined as the ability of a product to withstand wear, pressure and damage.

The durability of building materials are under the most stress in harsh winter conditions during freeze and thaw cycles especially when deicing salts are present. This expansion of water as it freezes can cause the exposed surfaces of saturated brick to deteriorate, which is referred to as spalling. Spalling is seen almost exclusively in older brick, reclaimed brick and brick imported from outside the United States that don't meet the rigorous ASTM (American Society for Testing Materials) Standards.

ASTM has multiple tests that all clay brick pavers must exceed for use "where the brick may be frozen with water while saturated" ensure that clay pavers are extremely durable in harsh freeze and thaw conditions.

24 Hour Cold Water Absorption

The 24 Hour Cold Water Absorption Test is a measurement of how much water a clay paver absorbs when submerged in cold water for 24 hours. The lower the amount of water absorbed by the clay paver the less water there is to expand under freezing conditions and the less likely a clay paver will spall.



Picture 1: Cold Water QC at the Plant

ASTM determined that a 24 Hour Cold Water Absorption that is less than 8% for Pedestrian and Light Vehicular Traffic (ASTM C902) and 6% for Heavy Vehicular Traffic (ASTM C1272) is critical to long-term durability.

Pine Hall Brick's clay pavers average less than 6% Cold Water Absorption.

Saturation Coefficient (C/B Ratio)

Clay pavers have capillaries and pores that absorb water. Cold water absorbs only into the capillary and then expand into the pore under freezing conditions. The pore must be large enough to allow frozen water to expand into it. The Pore Structure is illustrated in Figure 1.

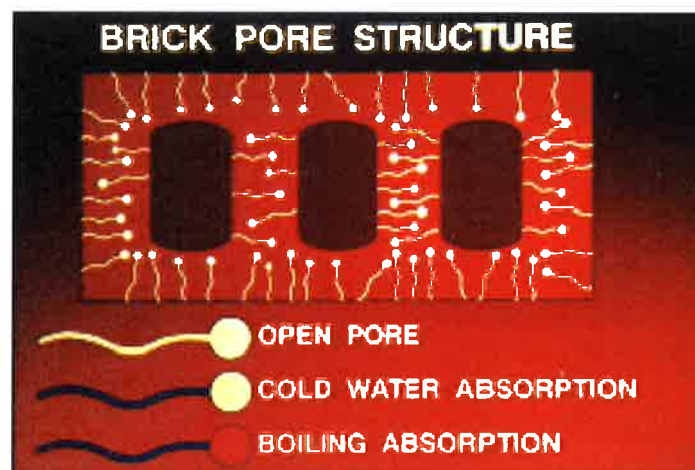


Figure 1: Brick Pore Structure

Saturation Coefficient also called the C/B Ratio is a way to measure the size of the open pores of a clay paver. It is calculated by dividing the 24 Hour Cold Water Absorption by the 5 Hour Boiling Water Absorption.

ASTM determined that a C/B Ratio that is no higher than .78 (22% Open Pore Area) is critical to long-term durability.

Pine Hall Brick's clay pavers average less than .65 C/B Ratio (35% Open Pore Area).

Compression Strength

Compressive Strength is the capacity of a material to withstand loading under pressure. It is measured by gradually applying an increasing load evenly across the entire clay paver until the paver fractures.

ASTM has determined that a minimum of 8,000 psi for Pedestrian and Light Vehicular (ASTM C902) and 10,000 psi for Heavy Vehicular (ASTM C1272) is critical to long-term durability.

All Pine Hall Brick's clay pavers have a compressive strength that exceed 12,000 psi.

Break Load

Break Load is the capacity of a material to withstand loading under pin-point pressure. It is measured by gradually applying an increasing load from above to the middle of a clay paver that is bridged across a void area until the paver fractures.

ASTM has determined that a minimum of 475 lb/in for Heavy Vehicular (ASTM C1272) is critical to long-term durability. Break Load is not required for Pedestrian & Light Vehicular Traffic (ASTM C902)



Picture 2: Break Load Test Machine

Pine Hall Brick's clay pavers have a Break Load that exceed 1,000 lb/in.

Pine Hall Brick's Physical Properties Compared to ASTM Standards

	Compressive Strength (psi)	Absorption (%)	Saturation Coefficient (max)	Break Load (lb/in)
ASTM C902, Class SX	8,000	8%	0.78	NR
ASTM C1272, Type F	10,000	6%	NR	450
English Edge 2.25"*	15,673	4.01%	0.60	NR
English Edge HD 2.75"*	16,632	3.15%	0.53	1,276

NR = Not Required

* = Independent Laboratory Test Results

State Of The Art Quality Control Standards

Pine Hall Brick's Quality Control begins with our raw material, triassic shale, which is tested frequently to make sure it has the right physical properties to manufacture the highest quality paving brick.

Unfired pavers are examined for quality and size throughout the day. Fired pavers are collected twice daily from strategic points on the kiln car to be tested for size and absorption. Fired pavers are pulled randomly from finished packages to verify earlier testing.

All runs of Heavy Vehicular Pavers are tested in-house for Break Loading. Samples are routinely submitted to independent laboratories to confirm their compliance with ASTM Standards.

Pine Hall Brick Passes Tough Canadian Freeze Thaw Test: CSA-A231.2 Canadian Freeze Thaw Test for Exposure to De-icing Salts

It is a well-known fact that brick pavers used in exterior applications can, in most locations of the country, be subject to extreme weather conditions. Clay units laid in a horizontal plane may be subject to saturation with water and exposed to freeze thaw cycles. This situation sets the stage for potential durability problems if the clay pavers are not fired to the proper degree of maturity. The severity of a potential problem is magnified by the presence of de-icing salts commonly used in winter conditions.



Picture 3: Rumbled Red Heavy Vehicular Pavers

While most clay pavers are tested regularly for resistance to freeze thaw cycles (ASTM C67), only the Canadian freeze thaw test CSA-A231.2 calls for the test to be conducted using a 3% saline (sodium chloride) solution. The test calls for three units to be completely immersed in the salt solution for 50 complete cycles. The criteria to pass the test state that the average loss of mass should not be greater than 200 g/m² after 25 cycles and 500 g/m² after 50 cycles.

Pine Hall Brick 2 ¼" clay pavers were submitted to the National Concrete Masonry Association's Research and Development Laboratory for this test. The results show that the pavers lost an average of only 6.2 g/m² in 25 cycles (standard allows 200g) and only 7.2g/m² in 50 cycles (standard allows 500g). This performance is testimony to the strength and durability of Pine Hall Brick clay pavers to withstand the most rigorous environments.

Results from Canadian Freeze Thaw Testing are attached in Appendix 1.



**NATIONAL
CONCRETE MASONRY
ASSOCIATION**

2302 Horse Pen Road
Herndon, VA 20171-3499
703-713-1900
Fax: 703-713-1910
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CSA A231.2 Test Report
Freeze-Thaw Durability

Job No.: 00-396-02
Report Date: 2/15/01

Client: Pine Hall Brick Co., Inc.
Address: PO Box 836
Madison, NC 27025-0836

Testing Agency: National Concrete Masonry Association
Research and Development Laboratory
Address: 2302 Horse Pen Road
Herndon, VA 20171

Unit Description
60 mm English Edge Paver
Red

Sampling Party: Pine Hall Brick Co., Inc.

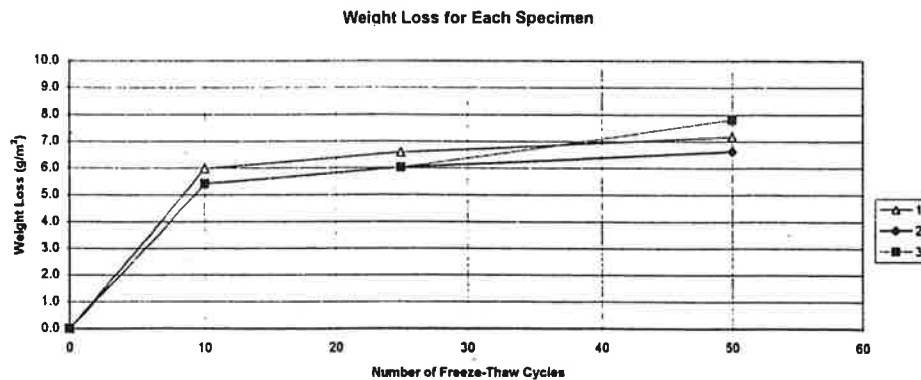
Test Specimen Dimensions: Full Size Pavers

Test Media: 3% SALINE

Unit No.	Average Height (mm)	Average Width (mm)	Average Length (mm)	Average Surface Area (m ²)
1	57.3	101.0	202.7	7.57E-02
2	56.9	100.7	202.2	7.52E-02
3	57.0	100.8	202.6	7.54E-02

Accumulative Residue Weight (g.)					
Unit No.	Cycle No.	0	10	25	50
1	0	0	0.4536	0.4989	0.5443
2	0	0	0.4082	0.4536	0.4989
3	0	0	0.4082	0.4536	0.5897

Specimen Weight Loss (g/m ²)					
Unit No.	Cycle No.	0	10	25	50
1	0	0.0	6.0	6.6	7.2
2	0	0.0	5.4	6.0	6.6
3	0	0.0	5.4	6.0	7.8



Comments: The tested values reported herein are for reference purposes only as there are no criteria for clay pavers in CSA A231.2. Criteria found in CSA A231.2 state that the average loss of mass of three full-size pavers should not be greater than 200 g/m² after 25 cycles or 500 g/m² after 50 cycles of freezing and thawing.

Robert S. Zobel, Ph.D.
Manager of Research and Development

**CSA A231.1 FREEZE THAW TEST RESULTS
PINE HALL PAVERS**

TEST UNIT	FREEZE THAW CYCLE	CUMULATIVE WEIGHT LOSS g / m ²	SPECIFICATION LIMIT
1	25	6.6	200
2		6	200
3		6	200
1	50	7.2	500
2		6.6	500
3		7.8	500

CSA A231.2 FREEZE THAW TEST RESULTS

