**STONE LABORATORY TEST REPORT**

**Report No.:** 24-0142.01-R0
**Test Date(s):** 11/14/24 – 01/29/25
**Report Date:** 02/04/25
**Retention Date:** 01/29/29

**Prepared for:** Jacobs Stone Products, Inc.
1210 W. Pierce Street
San Saba, TX 76877

**Product:** Natural Stone Product – Chapel Hill Limestone

**Scope: The** Natural Institute (NSI) was contracted by Jacobs Stone products, Inc. to perform physical properties evaluations for one natural limestone product (Chapel Hill). The scope of testing included absorption, density, compressive strength, modulus of rupture, flexural strength, abrasion resistance, slip resistance, and freeze-thaw durability for both cladding and paving installation conditions. All testing was performed at the NSI laboratory located in Oberlin, Ohio.

**Methods: The** products were evaluated in accordance with the following test method(s):

**ASTM C97/C97M-18,** *Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone*

**ASTM C170/C170M-24a,** *Standard Test Method for Compressive Strength of Dimension Stone*

**ASTM C99/C99M-24***, Standard Test Method for Modulus of Rupture of Dimension Stone*

**ASTM C1353/C1353M-20,** *Standard Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser*

**ANSI A326.3-2021 –** *American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials*

**ASTM C880/C880M-24,** *Standard Test Method for Flexural Strength of Dimension Stone*

**ASTM C666/C666M-15,** *Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing*

**ASTM C1645-22a,** *Standard Test Method for Freeze-Thaw and De-Icing Salt Durability of Solid Concrete Interlocking Paving Units*

**Methods:** *(cont.)*

**ASTM C568/C568M-22,** *Standard Specification for Limestone Dimension Stone*

**ASTM C936/C936M-24,** *Standard Specification for Solid Concrete Interlocking Paving Units*

**Test Materials:** Test materials were provided by Jacobs Stone products, Inc. on both 11/07/24 and 01/22/25 and were in good condition for testing. The product provided for testing was designated as Chapel Hill Limestone. Specimens were tested as received other than preconditioning as required by the applicable test method(s) prior to testing. Representative test materials shall be retained by the NSI for a period of four years.

**Test Witness Record**

| Name | Company |
|---|---|
| Clint Eads | NSI |
| Carmen Taran | NSI |
| Scott D. Scallorn | NSI |

**Test Procedure(s):** Unless otherwise stated, all specimen conditioning and testing was conducted in standard laboratory conditions. Test photos are located on pages 20-26 of this report. Equipment calibration certificates are available upon request.

**ASTM C97 - Absorption and Density Evaluation**

The absorption and density evaluations were conducted in accordance with the procedures detailed in ASTM C97. The specimens were dried in a ventilated oven maintained at 60°C (ICN: NSI00012) to a stable mass condition (minimum 48 hours), reacclimated to ambient lab temperature and weighed on an Ohaus digital balance (ICN: NSI00022) for determination of dry condition mass. They were then immersed in a filtered water bath maintained at 22°C temperature (verified by an Omega HH509R Thermometer (ICN: NSI00010) for 48 hours prior to individual specimen removal, surface drying and determination of wet condition mass. The specimens were then suspended in the water within a wire cage and weighed for determination of immersed condition mass. Absorption (%) and bulk specific gravity were calculated for each specimen as per the equations in ASTM C97, Section 9. Test results were averaged for the test series and evaluated against the performance criteria presented in ASTM C568, Table 1.

**ASTM C170 – Compressive Strength Evaluation**

The compressive strength evaluation was conducted on a Test Mark compression tester (ICN: NSI00001) in accordance with the procedures detailed in ASTM C170. Pretest specimen dimensions were measured with a 6" x 0.0005" Digital Caliper (ICN: NSI00008). Specimens were tested in both oven-dry and wet conditions. Dry condition specimens were oven-dried at 60°C for a minimum of 48 hours and cooled to ambient prior to testing. Wet condition specimens were immersed in water for 48 hours prior to individual removal and testing. Compressive strength was calculated for each specimen as per the equation in ASTM C170, Section 10.1. Test results were averaged for each test series and evaluated against the performance criteria presented in ASTM C568, Table 1.

**ASTM C99 – Modulus of Rupture Evaluation**

The Modulus of Rupture (MoR) evaluation was conducted on an ATS Universal Test Machine (ICN: NSI00003) employing a 12.5-kip load cell (ICN: NSI00004) in accordance with the procedures detailed in ASTM C99. Pretest specimen dimensions were measured with a 6" x 0.0005" Digital Caliper (ICN: NSI00008). Specimens were tested in both oven-dry and wet conditions. Dry condition specimens were oven-dried at 60°C for a minimum of 48 hours and cooled to ambient prior to testing. Wet condition specimens were immersed in water for 48 hours prior to individual removal and testing. Specimens were supported at a test span of 7.0 in. and loaded at midspan until failure. Flexural strength was calculated for each specimen as per the equation in ASTM C99, Section 11.1. Test results were averaged for each test series and evaluated against the performance criteria presented in ASTM C568, Table 1.

**ASTM C1353 – Abrasion Resistance Evaluation**

The abrasion resistance evaluation was conducted in accordance with the procedures detailed in ASTM C1353. The specimens were oven-dried at 60°C for a minimum of 48 hours and cooled prior to determination of pre-abrasion mass on an Ohaus digital balance (SN: B614316489) The specimens were then evaluated on a Taber Industries rotary platform abraser (SN: 20161679) employing H-22 Calibrade abrasive wheels with 1,000 grams of downward force applied to each for a total of 1000 wear cycles. Upon completion of cycling, post-exposure mass was determined for each specimen. Employing the bulk specific gravity results obtained from ASTM C97 evaluation, Index of Abrasion was calculated for each specimen as per the equation in ASTM C1353, Section 9.1. Test results were averaged for the series and evaluated against the performance criteria presented in ASTM C568, Table 1.

**ANSI A326.3 – Dynamic Coefficient of Friction (DCOF) Evaluation**

The DCOF evaluation was conducted in accordance with the procedures detailed in ANSI A326.3, sections 7 & 8. Specimens were evaluated with a BOT 3000E tribometer (ICN NSI00002) in wet condition (employing a 0.05% SLS solution). Four perpendicular passes were conducted, and test values averaged for each specimen. Individual specimen results were averaged for the test series and evaluated against the ANSI A326.3, Section 3.1 recommended wet condition performance criteria of 0.42.

**ASTM C666 – Freeze-Thaw Durability (Cladding Application)**

The freeze-thaw exposure cycling was conducted in modified ESPEC EPX-4H environmental conditioning chamber (ICN: NSI00015) in accordance with ASTM C666, Procedure B (Freeze-in-Air, Thaw-in-Water). The specimens were subjected to a total of 100 exposure cycles each consisting of lowering the temperature of wetted specimens from 40°F to 0°F in an air-surround condition and returning to 40°F in an immersed condition. Upon completion of each 25-cycle exposure increment, five specimens were removed from cycling and visually evaluated for breakage of other readily visible deleterious effects. The removed specimens were immersed in water for 48 hours prior to individual removal and testing in flexure as per ASTM C880 (detailed below).

**ASTM C880 – Flexural Strength**

The Flexural strength evaluation was conducted on an ATS Universal Test Machine Test Machine (ICN: NSI00003) employing a 12.5-kip load cell (ICN: NSI00004) in accordance with the procedures detailed in ASTM C880. Control series (no exposure cycling) specimens were tested in wet condition. Post-exposure series specimens were tested after 25, 50, 75, and 100 cycle completion and in wet condition only. The specimens were immersed in water for 48 hours prior to individual removal and testing. Specimens were supported at a test span of 12.5 in. and loaded at quarter point (6.25 in. loading span) until failure. Flexural strength was calculated for each specimen as per the equation in ASTM C880, Section 10.1. Test results for wet condition control series were averaged for each test series and the post-exposure mean flexural strength of each exposure series was evaluated against both the comparative zero-cycle wet condition control series and the preceding freeze-thaw exposure series for evaluation of potential strength loss.

**ASTM C1645 – Freeze-Thaw Durability Evaluation (Paving Application)**

The freeze-thaw durability evaluation was conducted in modified ESPEC EPX-4H environmental conditioning chamber (ICN: NSI00014) in accordance with the procedures detailed in ASTM C1645 without inclusion of de-icing salt considerations. The specimens were immersed in potable water for a period of 24 hours prior to initiation of cycling exposure. A total of 28 exposure cycles were conducted, each consisting of a 16 ± 1 hr. freezing period (to -5 ± 3°C [23 ± 5°F]) followed by an 8 ± 1 hr. thawing period (to 5°C [40°F]). Upon completion of both 7 and 28 cycles, specimen visual condition was documented and any loose debris in the exposure bin was collected. Debris was filtered from solution and oven dried to determine total mass loss relative to initial test specimen surface area. Mass loss results were averaged for the series and evaluated against the performance criteria presented in ASTM C936, Section 5.5. The post-exposure specimens were oven conditioned to equilibrium dry mass for additional visual evaluation of condition relative to the unexposed control specimen for the test series.

**Specimen Details**

| Test Method | Quantity | Nominal Dimensions | Description |
|---|---|---|---|
| ASTM C97 | 5 | 2.25 in. cubes | Light grey/white natural limestone with medium grey veining |
| ASTM C170 | 20 Total<br><br>Perpendicular, Wet: 5<br>Perpendicular, Dry: 5<br>Parallel, Dry: 5<br>Parallel, Wet: 5 | 2.25 in. cubes | |
| ASTM C99 | 20 Total<br><br>Perpendicular, Wet: 5<br>Perpendicular, Dry: 5<br>Parallel, Dry: 5<br>Parallel, Wet: 5 | 4 in. x 8 in. x 2.25 in. thickness | |
| ASTM C1353 | 3 | 4 in. square x 0.375 in. thickness | |
| ANSI A326.3 | 3 | 12 in. square x 1.25 in. thickness | |
| ASTM C880 | 5 Total<br><br>Perpendicular, Wet: 5 | 4 in. x 15 in. x 1.375 in. thickness | |
| ASTM C666 (ASTM C880) | 20 Total<br><br>Perpendicular:<br>25 Cycle: 5<br>50 Cycle: 5<br>75 Cycle: 5<br>100 Cycle: 5 | 4 in. x 15 in. x 1.375 in. thickness | |
| ASTM C1645 | 3 | 9 in. x 9 in. x 1.375 in. thickness | |

**Test Results**

**ASTM C97 – Absorption & Density Evaluation**

| Specimen No. | Measured Mass (g) | | | Absorption (%) | Bulk Specific Gravity | Density (lbs/ft$^3$) |
|---|---|---|---|---|---|---|
| | Oven-Dry | 48-Hour Wetted | Immersed Suspended | | | |
| **1** | 526.15 | 529.30 | 333.04 | 0.60 | 2.681 | 167.4 |
| **2** | 523.39 | 526.40 | 331.06 | 0.58 | 2.679 | 167.2 |
| **3** | 498.68 | 501.88 | 315.41 | 0.64 | 2.674 | 166.9 |
| **4** | 504.56 | 507.40 | 319.74 | 0.56 | 2.689 | 167.9 |
| **5** | 525.32 | 528.33 | 322.47 | 0.57 | 2.552 | 159.3 |
| **Series Average** | | | | **0.59** | **2.655** | **166.0** |
| **Standard Deviation** | | | | 0.03 | 0.058 | 3.62 |
| **Coefficient of Variation (%)** | | | | 5.35 | 2.178 | 2.18 |

**ASTM C170 – Compressive Strength Evaluation – Wet Condition, Perpendicular Loading**

| Specimen No. | Test Condition | Specimen Dimensions (in) | | Loading Area ($in^2$) | Failure Load ($lb_f$) | Compressive Strength (psi) |
|---|---|---|---|---|---|---|
| | | Length | Width | | | |
| **PP-W-1** | Loaded Perpendicular to stone rift plane<br><br>Wet Condition | 2.29 | 2.24 | 5.11 | 92,400 | 18,080 |
| **PP-W-2** | | 2.23 | 2.24 | 5.00 | 77,080 | 15,420 |
| **PP-W-3** | | 2.24 | 2.23 | 4.98 | 87,310 | 17,530 |
| **PP-W-4** | | 2.26 | 2.31 | 5.21 | 81,710 | 15,680 |
| **PP-W-5** | | 2.26 | 2.24 | 5.05 | 73,030 | 14,460 |
| **Series Average** | | | | | | **16,230** |
| **Standard Deviation** | | | | | | 1,517 |
| **Coefficient of Variation (%)** | | | | | | 9.3 |

**ASTM C170 – Compressive Strength Evaluation – Dry Condition, Perpendicular Loading**

| Specimen No. | Test Condition | Specimen Dimensions (in) | | Loading Area ($in^2$) | Failure Load ($lb_f$) | Compressive Strength (psi) |
|---|---|---|---|---|---|---|
| | | Length | Width | | | |
| **PP-D-1** | Loaded Perpendicular to stone rift plane<br><br>Dry Condition | 2.24 | 2.26 | 5.08 | 110,140 | 21,680 |
| **PP-D-2** | | 2.24 | 2.32 | 5.21 | 96,590 | 18,540 |
| **PP-D-3** | | 2.34 | 2.25 | 5.26 | 100,510 | 19,110 |
| **PP-D-4** | | 2.24 | 2.24 | 5.02 | 76,980 | 15,330 |
| **PP-D-5** | | 2.24 | 2.29 | 5.14 | 90,630 | 17,630 |
| **Series Average** | | | | | | **18,460** |
| **Standard Deviation** | | | | | | 2,307 |
| **Coefficient of Variation (%)** | | | | | | 12.5 |

**ASTM C170 – Compressive Strength Evaluation – Wet Condition, Parallel Loading**

| Specimen No. | Test Condition | Specimen Dimensions (in) | | Loading Area ($in^2$) | Failure Load ($lb_f$) | Compressive Strength (psi) |
|---|---|---|---|---|---|---|
| | | Length | Width | | | |
| **LL-W-1** | Loaded Parallel to stone rift plane<br><br>Wet Condition | 2.30 | 2.26 | 5.19 | 96,310 | 18,560 |
| **LL-W-2** | | 2.25 | 2.30 | 5.19 | 68,300 | 13,160 |
| **LL-W-3** | | 2.30 | 2.26 | 5.20 | 65,480 | 12,590 |
| **LL-W-4** | | 2.30 | 2.23 | 5.12 | 76,500 | 14,940 |
| **LL-W-5** | | 2.30 | 2.25 | 5.17 | 88,690 | 17,150 |
| **Series Average** | | | | | | **15,280** |
| **Standard Deviation** | | | | | | 2,554 |
| **Coefficient of Variation (%)** | | | | | | 16.7 |

**ASTM C170 – Compressive Strength Evaluation – Dry Condition, Parallel Loading**

| Specimen No. | Test Condition | Specimen Dimensions (in) | | Loading Area ($in^2$) | Failure Load ($lb_f$) | Compressive Strength (psi) |
|---|---|---|---|---|---|---|
| | | Length | Width | | | |
| **LL-D-1** | Loaded Parallel to stone rift plane<br><br>Dry Condition | 2.31 | 2.22 | 5.13 | 122,630 | 23,900 |
| **LL-D-2** | | 2.24 | 2.24 | 5.00 | 61,840 | 12,370 |
| **LL-D-3** | | 2.24 | 2.29 | 5.13 | 111,800 | 21,790 |
| **LL-D-4** | | 2.27 | 2.25 | 5.10 | 87,880 | 17,230 |
| **LL-D-5** | | 2.23 | 2.23 | 4.98 | 69,480 | 13,950 |
| **Series Average** | | | | | | **17,850** |
| **Standard Deviation** | | | | | | 4,943 |
| **Coefficient of Variation (%)** | | | | | | 27.7 |

**ASTM C99 – Modulus of Rupture Evaluation – Wet Condition, Perpendicular Loading**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Modulus of Rupture (psi) |
|---|---|---|---|---|---|---|
| **No.** | **Test Condition** | | **Width** | **Depth** | | |
| **PP-W-1** | Loaded Perpendicular to stone rift plane<br><br>Wet Condition | 7.0 | 3.98 | 2.38 | 3,359 | 1,560 |
| **PP-W-2** | | | 3.98 | 2.40 | 3,422 | 1,570 |
| **PP-W-3** | | | 4.00 | 2.34 | 3,377 | 1,630 |
| **PP-W-4** | | | 4.01 | 2.33 | 3,374 | 1,630 |
| **PP-W-5** | | | 4.00 | 2.33 | 3,144 | 1,520 |
| **Series Average** | | | | | | **1,580** |
| **Standard Deviation** | | | | | | 48 |
| **Coefficient of Variation (%)** | | | | | | 3.0 |

**ASTM C99 – Modulus of Rupture Evaluation – Dry Condition, Perpendicular Loading**

| Specimen No. | Test Conditions | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Modulus of Rupture (psi) |
|---|---|---|---|---|---|---|
| | | | **Width** | **Depth** | | |
| **PP-D-1** | Loaded Perpendicular to stone rift plane<br><br>Dry Condition | 7.0 | 4.01 | 2.33 | 3,712 | 1,790 |
| **PP-D-2** | | | 3.99 | 2.33 | 3,114 | 1,510 |
| **PP-D-3** | | | 4.00 | 2.38 | 3,470 | 1,600 |
| **PP-D-4** | | | 4.00 | 2.34 | 4,027 | 1,930 |
| **PP-D-5** | | | 3.99 | 2.33 | 4,184 | 2,030 |
| **Series Average** | | | | | | **1,770** |
| **Standard Deviation** | | | | | | 218 |
| **Coefficient of Variation (%)** | | | | | | 12.3 |

**ASTM C99 – Modulus of Rupture Evaluation – Wet Condition, Parallel Loading**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Modulus of Rupture (psi) |
|---|---|---|---|---|---|---|
| **No.** | **Test Condition** | | **Width** | **Depth** | | |
| **LL-W-1** | Loaded Parallel to stone rift plane<br><br>Wet Condition | 7.0 | 4.06 | 2.26 | 2,960 | 1,500 |
| **LL-W-2** | | | 4.05 | 2.26 | 3,288 | 1,670 |
| **LL-W-3** | | | 4.05 | 2.28 | 2,848 | 1,430 |
| **LL-W-4** | | | 4.03 | 2.26 | 2,819 | 1,440 |
| **LL-W-5** | | | 4.04 | 2.22 | 2,588 | 1,370 |
| **Series Average** | | | | | | **1,480** |
| **Standard Deviation** | | | | | | 115 |
| **Coefficient of Variation (%)** | | | | | | 7.8 |

**ASTM C99 – Modulus of Rupture Evaluation – Dry Condition, Parallel Loading**

| Specimen No. | Test Conditions | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Modulus of Rupture (psi) |
|---|---|---|---|---|---|---|
| | | | **Width** | **Depth** | | |
| **LL-D-1** | Loaded Parallel to stone rift plane<br><br>Dry Condition | 7.0 | 4.05 | 2.22 | 3,480 | 1,840 |
| **LL-D-2** | | | 4.04 | 2.23 | 3,202 | 1,670 |
| **LL-D-3** | | | 4.06 | 2.23 | 3,408 | 1,780 |
| **LL-D-4** | | | 4.05 | 2.23 | 3,286 | 1,720 |
| **LL-D-5** | | | 4.06 | 2.21 | 3,144 | 1,670 |
| **Series Average** | | | | | | **1,740** |
| **Standard Deviation** | | | | | | 74 |
| **Coefficient of Variation (%)** | | | | | | 4.3 |

**ASTM C1353 – Abrasion Resistance Evaluation**

| Specimen No. | Bulk Specific Gravity | Mass (g) | | | Wear Cycles Completed | Index of Abrasion |
|---|---|---|---|---|---|---|
| | | Initial | End | Loss | | |
| 1 | 2.655 | 192.20 | 188.52 | 3.68 | 1,000 | 26.5 |
| 2 | | 184.23 | 179.86 | 4.37 | | 22.3 |
| 3 | | 193.17 | 188.29 | 4.88 | | 20.0 |
| **Series Average** | | | | | | **22.9** |
| **Standard Deviation** | | | | | | 3.3 |
| **Coefficient of Variation (%)** | | | | | | 14.4 |

**ANSI A326.3 - Dynamic Coefficient of Friction**

**Sawn Finish (Wet Condition)**

| Specimen No. | Test Orientation | | | | Wet Condition DCOF |
|---|---|---|---|---|---|
| | 0° | 90° | 180° | 270° | |
| **Wet - 1** | 0.79 | 0.81 | 0.77 | 0.78 | 0.79 |
| **Wet - 2** | 0.80 | 0.81 | 0.79 | 0.79 | 0.80 |
| **Wet - 3** | 0.81 | 0.83 | 0.77 | 0.78 | 0.80 |
| **Series Average** | | | | | **0.79** |
| **Standard Deviation** | | | | | 0.02 |
| **Coefficient of Variation (%)** | | | | | 2.3 |

**ASTM C880 – Flexural Strength Evaluation – Wet Condition, Perpendicular Loading**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Flexural Strength (psi) |
|---|---|---|---|---|---|---|
| No. | Test Condition | | Width | Depth | | |
| **PP-W-1** | Loaded Perpendicular to stone rift plane<br><br>Wet Condition | 12.5 | 3.99 | 1.41 | 1,140 | 1,360 |
| **PP-W-2** | | | 4.00 | 1.36 | 1,080 | 1,370 |
| **PP-W-3** | | | 4.02 | 1.36 | 1,187 | 1,510 |
| **PP-W-4** | | | 4.01 | 1.34 | 988 | 1,300 |
| **PP-W-5** | | | 3.97 | 1.34 | 1,000 | 1,320 |
| **Series Average** | | | | | | **1,370** |
| **Standard Deviation** | | | | | | 82 |
| **Coefficient of Variation (%)** | | | | | | 6.0 |

**ASTM C666 – Post Freeze-Thaw Flexural Strength**
**Test Condition: Perpendicular Rift, 25-Cycle (Wet)**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load (lbf) | Flexural Strength (psi) |
|---|---|---|---|---|---|---|
| **No.** | **Test Condition** | | **Width** | **Depth** | | |
| PP-FT25-1 | Loaded Perpendicular to stone rift plane<br><br>Post 25-Cycles Freeze-Thaw Exposure<br><br>Wet Condition | 12.5 | 3.98 | 1.33 | 986 | 1,310 |
| PP-FT25-2 | | | 4.01 | 1.35 | 1,145 | 1,470 |
| PP-FT25-3 | | | 4.00 | 1.40 | 1,089 | 1,300 |
| PP-FT25-4 | | | 3.99 | 1.34 | 944 | 1,230 |
| PP-FT25-5 | | | 3.98 | 1.42 | 1,165 | 1,360 |
| **Series Average** | | | | | | **1,330** |
| **Standard Deviation** | | | | | | 89 |
| **Coefficient of Variation (%)** | | | | | | 6.7 |

- ***No 25-cycle specimen showed readily visible signs of degradation post-exposure.***

**Post Freeze-Thaw Comparative Flexural Strength Evaluation (25 Cycles C666, Proc. B)**

| Evaluation Condition | | Result (% Change) |
|---|---|---|
| Perpendicular stone rift plane | Against Wet Condition Control | -2.9 |
| | Against Preceding Freeze-Thaw Exposure Se | N/A |

**ASTM C666 – Post Freeze-Thaw Flexural Strength**
**Test Condition: Perpendicular Rift, 50-Cycle (Wet)**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load (lbf) | Flexural Strength (psi) |
|---|---|---|---|---|---|---|
| **No.** | **Test Condition** | | **Width** | **Depth** | | |
| PP-FT50-1 | Loaded Perpendicular to stone rift plane<br><br>Post 50-Cycles Freeze-Thaw Exposure<br><br>Wet Condition | 12.5 | 3.99 | 1.36 | 489 | 630 |
| PP-FT50-2 | | | 4.03 | 1.45 | 1,488 | 1,650 |
| PP-FT50-3 | | | 4.01 | 1.37 | 1,091 | 1,370 |
| PP-FT50-4 | | | 3.99 | 1.34 | 1,121 | 1,480 |
| PP-FT50-5 | | | 4.01 | 1.36 | 1,041 | 1,320 |
| **Series Average** | | | | | | **1,290** |
| **Standard Deviation** | | | | | | 390 |
| **Coefficient of Variation (%)** | | | | | | 30.2 |

- ***No 50-cycle specimen showed readily visible signs of degradation post-exposure.***

**Post Freeze-Thaw Comparative Flexural Strength Evaluation (50 Cycles C666, Proc. B)**

| Evaluation Condition | | Result (% Change) |
|---|---|---|
| Perpendicular stone rift plane | Against Wet Condition Control | -5.8 |
| | Against Preceding Freeze-Thaw Exposure Set | -3.0 |

**ASTM C666 – Post Freeze-Thaw Flexural Strength**
**Test Condition: Perpendicular Rift, 75-Cycle (Wet)**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load (lbf) | Flexural Strength (psi) |
|---|---|---|---|---|---|---|
| **No.** | **Test Condition** | | **Width** | **Depth** | | |
| PP-FT75-1 | Loaded Perpendicular to stone rift plane<br><br>Post 75-Cycles Freeze-Thaw Exposure<br><br>Wet Condition | 12.5 | 3.99 | 1.34 | 978 | 1,290 |
| PP-FT75-2 | | | 4.00 | 1.34 | 1,045 | 1,370 |
| PP-FT75-3 | | | 3.98 | 1.40 | 1,246 | 1,490 |
| PP-FT75-4 | | | 4.03 | 1.45 | 1,297 | 1,440 |
| PP-FT75-5 | | | 3.98 | 1.42 | 1,299 | 1,520 |
| **Series Average** | | | | | | **1,420** |
| **Standard Deviation** | | | | | | 93 |
| **Coefficient of Variation (%)** | | | | | | 6.5 |

- ***No 75-cycle specimen showed readily visible signs of degradation post-exposure.***

**Post Freeze-Thaw Comparative Flexural Strength Evaluation (75 Cycles C666, Proc. B)**

| Evaluation Condition | | Result (% Change) |
|---|---|---|
| Perpendicular stone rift plane | Against Wet Condition Control | +3.6 |
| | Against Preceding Freeze-Thaw Exposure Set | +10.1 |

**ASTM C666 – Post Freeze-Thaw Flexural Strength**
**Test Condition: Perpendicular Rift, 100-Cycle (Wet)**

| Specimen Details | | Support Span (in) | Specimen Dimensions (in) | | Failure Load ($lb_f$) | Flexural Strength (psi) |
|---|---|---|---|---|---|---|
| No. | Test Condition | | Width | Depth | | |
| PP-FT100-1 | Loaded Perpendicular to stone rift plane | 12.5 | 3.99 | 1.33 | 708 | 940 |
| PP-FT100-2 | | | 3.98 | 1.40 | 1,235 | 1,490 |
| PP-FT100-3 | Post 100-Cycles Freeze-Thaw Exposure | | 3.98 | 1.40 | 1,288 | 1,550 |
| PP-FT100-4 | | | 3.99 | 1.40 | 1,188 | 1,430 |
| PP-FT100-5 | Wet Condition | | 3.99 | 1.41 | 923 | 1,100 |
| **Series Average** | | | | | | **1,300** |
| **Standard Deviation** | | | | | | 267 |
| **Coefficient of Variation (%)** | | | | | | 20.5 |

- ***No 100-cycle specimen showed readily visible signs of degradation post-exposure.***

**Post Freeze-Thaw Comparative Flexural Strength Evaluation (100 Cycles C666, Proc. B)**

| Evaluation Condition | | Result (% Change) |
|---|---|---|
| Perpendicular stone rift plane | Against Wet Condition Control | -5.1 |
| | Against Preceding Freeze-Thaw Exposure Set | -8.5 |

**ASTM C1645 – Paving Freeze-Thaw Durability**

| Specimen No. | Specimen Surface Area | | Collected Residue Mass (g) | | | Mass Loss $g/m^2$ |
|---|---|---|---|---|---|---|
| | $in^2$ | $m^2$ | 7-Day | 28-Day | Total | |
| **1** | 211.4 | 0.1364 | 0.06 | 2.63 | 2.69 | **19.6** |
| **2** | | | 0.20 | 4.88 | 5.08 | **37.3** |
| **3** | | | 0.51 | 13.67 | 14.18 | **104.4** |
| **Series Average** | | | | | | **53.8** |
| **Standard Deviation** | | | | | | 44.7 |
| **Coefficient of Variation (%)** | | | | | | 83.2 |

| Specimen No. | Visual Evaluation |
|---|---|
| **1** | Slight Spalling, No other deleterious effects |
| **2** | Isolated/Light Spalling, No other deleterious effects |
| **3** | Isolated/Light-Moderate Spalling, No other deleterious effects |

**Conclusion:** The average test results were evaluated against the performance criteria presented in ASTM C568 Table 1, ANSI A326.3, and ASTM C936, Section 5.5. The results of these evaluations are presented in the table(s) below:

| **ASTM C568 Performance Evaluation Summary** | | | | |
|---|---|---|---|---|
| **Physical Requirement** | **Test Series Detail** | | **Result** | |
| | | | **Mean Test Value** | **Performance Evaluation** |
| **C97 Absorption (%):**<br>Class I (Low Density): ≤12.0<br>Class II (Medium Density): ≤7.5.0<br>Class III (High Density): ≤3.0 | | | 0.59 | Meets as Stated: Class III |
| **C97 Density (lbs/ft$^3$):**<br>Class I (Low Density): ≥110<br>Class II (Medium Density): ≥135<br>Class III (High Density): ≥160 | | | 166.0 | Meets as Stated: Class III |
| **C170 Compressive Strength (psi):**<br>Class I (Low Density): ≥1,800<br>Class II (Medium Density): ≥4,000<br>Class III (High Density): ≥8,000 | Perpendicular | Wet | 16,230 | Meets as Stated: Class III |
| | | Dry | 18,460 | |
| | Parallel | Wet | 15,280 | |
| | | Dry | 17,850 | |
| **C99 Modulus of Rupture (psi):**<br>Class I (Low Density): ≥400<br>Class II (Medium Density): ≥500<br>Class III (High Density): ≥1,000 | Perpendicular | Wet | 1,580 | Meets as Stated: Class III |
| | | Dry | 1,770 | |
| | Parallel | Wet | 1,480 | |
| | | Dry | 1,740 | |
| **C1353 Abrasion Resistance:**<br>Class I (Low Density): $H_a$ ≥10<br>Class II (Medium Density): $H_a$ ≥10<br>Class III (High Density): $H_a$ ≥10 | | | 22.9 | Meets as Stated: Class III |
| **C880 Flexural Strength (psi):**<br>No Performance Criteria Stated | Perpendicular | Wet | 1,370 | Design Property Only |
| **C666/C880 Post-Freeze-Thaw Exposure Flexural Strength (psi):**<br>No Performance Criteria Stated | Perpendicular (Wet) | 25 Cycles | 1,330 | Design Property Only |
| | | 50 Cycles | 1,290 | |
| | | 75 Cycles | 1,420 | |
| | | 100 Cycles | 1,300 | |

| ANSI A326.3 Performance Evaluation Summary | | | |
|---|---|---|---|
| **Physical Requirement** | **Test Series Detail** | **Result** | |
| | | **Mean Test Value** | **Performance Evaluation** |
| **ANSI A326.3 - Dynamic Coefficient of Friction (Wet):** DCOF ≥0.42 | Sawn Finish | 0.79 | Meets as Stated |

| ASTM C666 (ASTM C880) Freeze-Thaw Comparative Flexural Strength Evaluation Summary | | | | |
|---|---|---|---|---|
| **Test Series** | **Test Condition** | **Series Mean Wet Flexural Strength (psi)** | **Comparative Performance Evaluation (%)** | |
| | | | **vs. Wet Control** | **vs. Preceding Freeze-Thaw Exposure Set** |
| 0 Cycle (Wet) | Perpendicular<br><br>Wet | 1,370 | N/A | N/A |
| 25 Cycles (Wet) | | 1,330 | -2.9 | N/A |
| 50 Cycles (Wet) | | 1,290 | -5.8 | -3.0 |
| 75 Cycles (Wet) | | 1,420 | +3.6 | +10.1 |
| 100 Cycles (Wet) | | 1,300 | -5.1 | -8.5 |

| ASTM C936 (ASTM C1645) Performance Evaluation Summary | | | |
|---|---|---|---|
| **Physical Requirement** | **Mass Loss Result** | | **Post-Exposure Specimen Condition** |
| | **Mean Test Value ($g/m^2$)** | **ASTM C936 Performance Evaluation** | |
| **<u>ASTM C1645 – Freeze-Thaw Durability:</u>**<br><br>After 28 cycles, total mass loss shall be equal to or less than $225 g/m^2$ | 53.8<br><br>High: 104.4 | Meets as Stated | Isolated/Light Surface Spalling |

**ASTM C568 – Limestone Properties Evaluation**

The Chapel Hill limestone product satisfied the ASTM C568 performance requirements for a Class III (High-Density) Limestone product for Absorption, Density, Compressive Strength, Modulus of Rupture, and Abrasion Resistance.

There are no ASTM C568 performance criteria for ASTM C880 Flexural Strength, so these values are reported as a design property only.

**ANSI A325.3 Evaluation**

The Chapel Hill limestone product (sawn finish) satisfied the ANSI A326.3 recommended minimum performance criteria of 0.42 DCOF for wet condition (Mean Wet Condition DCOF: 0.79).

**ASTM C666 – Freeze-Thaw Durability Evaluation (Cladding Application)**

The Chapel Hill limestone post-exposure freeze-thaw specimens showed no readily visible signs of degradation post-exposure. Incremental post-exposure flexural strength values varied up and down between test series, and the mean documented strength change between control series and post-100 exposure cycles was -5.1%. As such, the range of values observed are more likely due to variations within individual test specimens rather than any appreciable freeze-thaw induced strength degradation.

**ASTM C1645 (ASTM C936) – Freeze-Thaw Durability Evaluation (Paving Application)**

The Chapel Hill limestone product satisfied the minimum mass loss requirement presented in ASTM C936 for freeze-thaw durability but expressed isolated/light surface spalling post 28-cycle exposure completion. The specimens showed no other signs of degradation (cracking, color shift, or other deleterious effects) post exposure.

It has been our pleasure to provide this product testing service for your project. Please do not hesitate to contact us if you have any questions or require additional information. Contact information is listed below.

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**Revision Log**

| No. | Date | Page(s) | Description |
|---|---|---|---|
| 0 | 02/04/25 | N/A | Initial report release |
| | | | |

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**Photographs:**

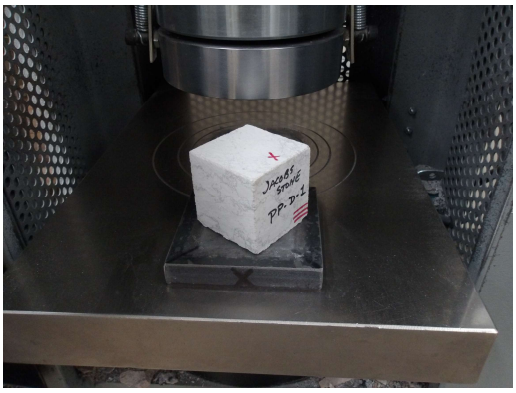

**Photo No. 1**
ASTM C170 – Representative Pretest Condition Specimen

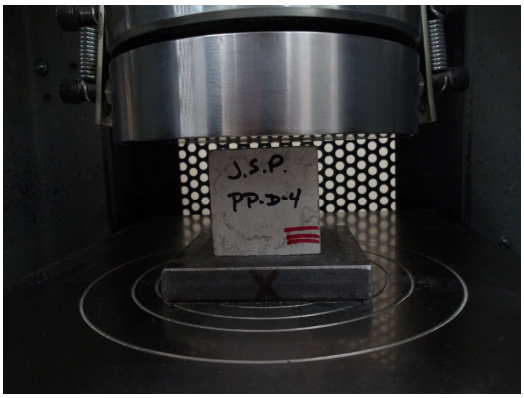


**Photo No. 2**
ASTM C170 – Test Setup

**Photo No. 3**
ASTM C170 – Specimen Failure Mode: Loading Parallel to Rift (Dry Condition)

**Photo No. 4**
ASTM C170 – Specimen Failure Mode: Loading Perpendicular to Rift (Wet Condition)

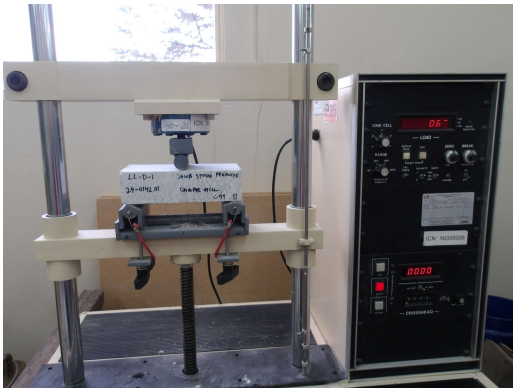

**Photo No. 5**
ASTM C99 – Modulus of Rupture
Test Setup


**Photo No. 6**
ASTM C99 – Specimen Failure Mode:
Loading Parallel to Rift
(Dry Condition)


**Photo No. 7**
ASTM C99 – Specimen Failure Mode:
Loading Perpendicular to Rift
(Dry Condition)


**Photo No. 8**
ASTM C99 – Specimen Failure Mode:
Loading Parallel to Rift
(Wet Condition)


**Photo No. 9**
ASTM C97 – Absorption & Density
Specimen Test Setup

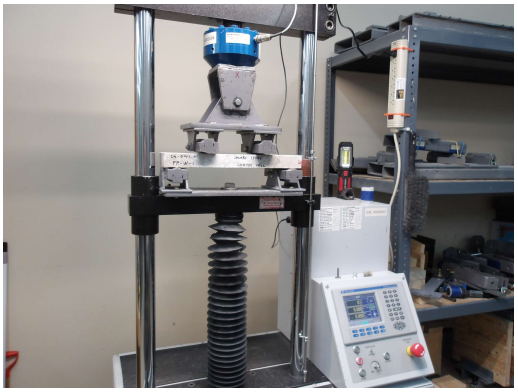

**Photo No. 10**
ASTM C880 – Flexural Strength
Test Setup

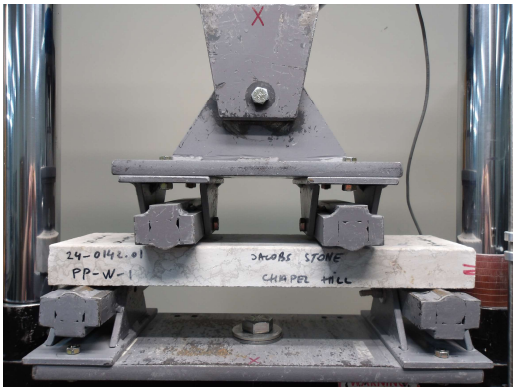


**Photo No. 11**
ASTM C880 – Specimen Loading Detail

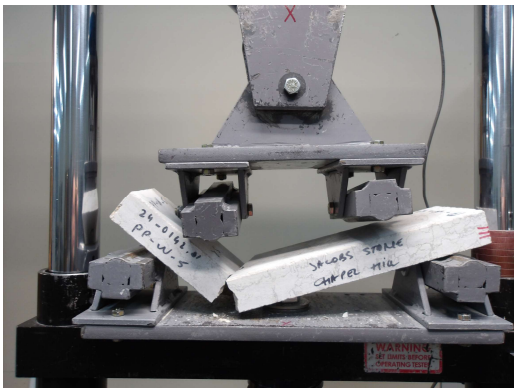


**Photo No. 12**
ASTM C880 – Specimen Failure Mode:
Loading Parallel to Rift
(Wet Condition)


**Photo No. 13**
ASTM C666 (C880) – Failure Mode:
Representative 25-Cycle Specimen
(Perpendicular, Wet Condition)


**Photo No. 14**
ASTM C666 (C880) – Failure Mode:
Representative 50-Cycle Specimen
(Perpendicular, Wet Condition)

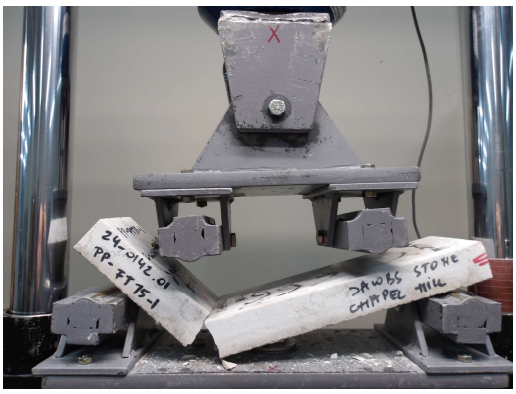


**Photo No. 15**
ASTM C666 (C880) – Failure Mode:
Representative 75-Cycle Specimen
(Perpendicular, Wet Condition)


**Photo No. 16**
ASTM C666 (C880) – Failure Mode:
Representative 100-Cycle Specimen
(Perpendicular, Wet Condition)


**Photo No. 17**
ASTM C1353 – Representative Pretest Specimen Condition


**Photo No. 18**
ASTM C1353 – Abrasion Test Setup


**Photo No. 19**
ASTM C1353 – Test in Progress


**Photo No. 20**
ASTM C1353 – Post-Abrasion Specimen Condition

**Photo No. 21**
BOT 3000E Test Apparatus

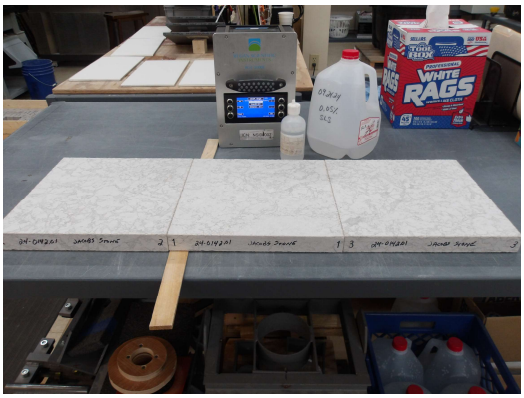


**Photo No. 22**
ANSI A326.3 – DCOF Evaluation
Test Setup

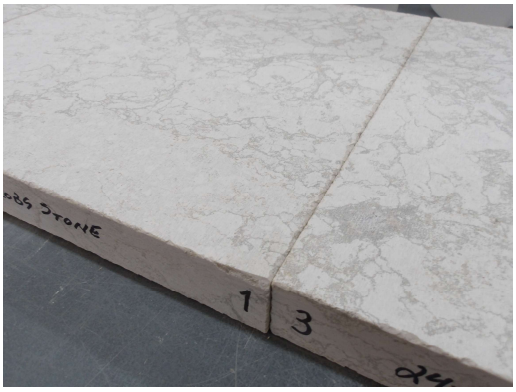


**Photo No. 23**
Surface Detail – Chapel Hill Limestone
(Sawn Finish)

**Photo No. 24**
ANSI A326.3 – DCOF Test in Progress

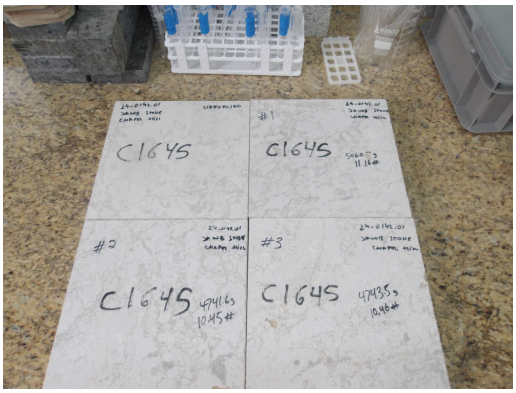


**Photo No. 25**
ASTM C1645 – Comparative Post-Exposure Exterior Facing (Unexposed Control Depicted Top Left, Post-Exposure Depicted Top Right, Bottom Left and Right)

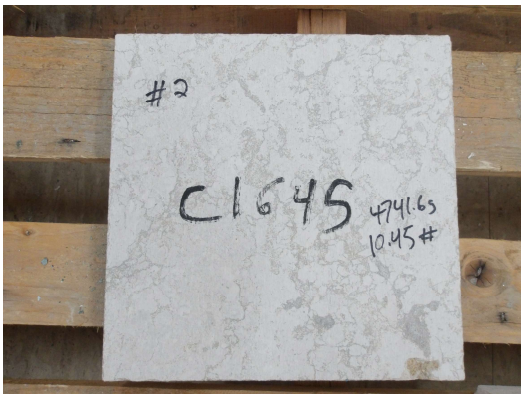


**Photo No. 26**
ASTM C1645 – Specimen No. 2 Exterior Facing (Maximum Top Face Spalling Specimen Condition Observed)

**Photo No. 27**
ASTM C1645 – Specimen No. 3 Underside Facing (Maximum Rear Face Spalling Specimen Condition Observed)

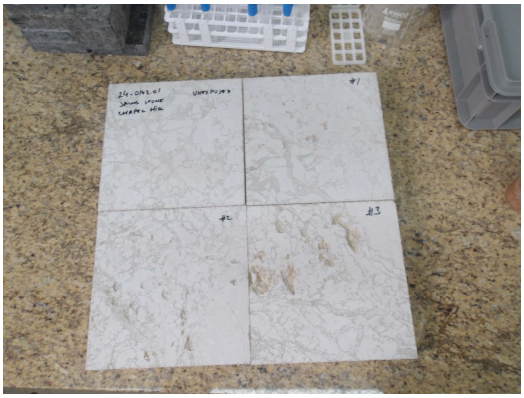

**Photo No. 28**
ASTM C1645 – Comparative Post-Exposure Underside Facing (Unexposed Control Depicted Top Left, Post-Exposure Depicted Top Right, Bottom Left and Right)