STONE LABORATORY TEST REPORT

Report No.: 24-0227.01-R0
Test Date(s): 03/10/25 – 04/26/25
Report Date: 04/26/25
Retention Date: 04/26/29

Prepared for: Mr. Justin Lindblad
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1432 Teton
Billings, MT 59102

Product: One Natural Travertine Product (Continental Buff)

Scope: The Natural Institute (NSI) was contracted by Yellowstone Rock to perform physical properties evaluations for one natural travertine product (Continental Buff). The scope of testing included Flexural Strength, Freeze-Thaw Durability, and Resistance to Salt Crystallization. All testing was performed at the NSI laboratory located in Oberlin, Ohio.

Methods: The products were evaluated in accordance with the following test method:

ASTM C880/C880M-25, *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*

EN 12370-20 *Natural stone test methods, Determination of resistance to salt crystallization*

ASTM C1527/C1527M-23, *Standard Specification for Travertine Dimension Stone.*

Test Materials: Test materials were provided by Yellowstone Rock and were received in good condition for testing on 02/24/25. Stone was designated by client Continental Buff. 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
Scott Scallorn	NSI
Carmen Taran	NSI
Jeffrey Terleckyj	NSI

Test Procedure(s): Unless otherwise stated, all specimen conditioning and testing was conducted at standard laboratory conditions. Test photos are located on pages 9-11 of this report. Equipment calibration certificates are available upon request.

ASTM C666 – Freeze-Thaw Durability

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.

EN 12370 – Salt Crystallization Resistance Evaluation

The salt crystallization evaluation was conducted in accordance with the procedures detailed in EN 12370. The specimens were hand washed in potable water to remove any residue from production prior to oven-conditioning at 105 ± 5°C until constant dry mass was achieved. The oven-dry specimens were allowed to cool and weighed on an Ohaus digital balance (ICN: NSI00022) prior to immersion to a coverage depth of 8 ± 2mm in a 14% sodium sulphate decahydrate solution maintained at 20 ± 0.5°C for a period of 2 hours. Post-immersion, the specimens were transferred to a high humidity oven maintained at 105 ± 5°C for 16 hours prior to cooling and re-immersion in a fresh sodium sulphate solution. After the completion of 15 cycles, the specimens were removed from the oven and stored for 24 hours in a water bath maintained at 23 ± 5°C. If sufficiently coherent, the specimens were then redried and reweighed to determine mass loss post-exposure.

Specimen Details

Test Method	Quantity	Nominal Dimensions	Description
ASTM C880	5 Total Perpendicular, Wet: 5	4.0 in. x 15.0 in. x 1.25 in.	Cream tone natural travertine
ASTM C666 (ASTM C880)	20 Total, Wet 25 Cycle: 5 Perp 50 Cycle: 5 Perp 75 Cycle: 5 Perp 100 Cycle: 5 Perp	4.0 in. x 15.0 in. x 1.25 in.	
EN 12370	6 Total	1.6 in. Cubes	

Test Results

ASTM C880 – Flexural Strength
Test Condition: Perpendicular Loading, Wet

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 the stone rift plane Wet Condition	12.5	4.01	1.15	718	1,260
PP-W-2			4.02	1.09	442	860
PP-W-3			4.01	1.12	645	1,200
PP-W-4			4.01	1.13	621	1,150
PP-W-5			4.01	1.15	527	940
Series Average						**1,080**
Standard Deviation						173
Coefficient of Variation (%)						16.0

ASTM C666 – Post Freeze-Thaw Flexural Strength – 25-Cycle (Wet), Perpendicular Loading

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb_f)	Flexural Strength (psi)
No.	**Test Condition**		**Width**	**Depth**		
PP-FT25-1	Loaded Perpendicular to stone rift plane Wet Condition	12.5	4.01	1.44	623	700
PP-FT25-2			4.01	1.14	595	1,080
PP-FT25-3			4.01	1.12	532	990
PP-FT25-4			4.01	1.10	515	990
PP-FT25-5			4.02	1.11	661	1,260
Series Average						**1,000**
Standard Deviation						203
Coefficient of Variation (%)						20.3

- ***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	-7.4
	Against Preceding Freeze-Thaw Exposure Se	N/A

ASTM C666 – Post Freeze-Thaw Flexural Strength – 50-Cycle (Wet), Perpendicular Loading

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb_f)	Flexural Strength (psi)
No.	**Test Condition**		**Width**	**Depth**		
PP-FT50-1	Loaded Perpendicular to stone rift plane Wet Condition	12.5	4.00	1.12	548	1,020
PP-FT50-2			4.00	1.12	559	1,040
PP-FT50-3			4.01	1.10	514	990
PP-FT50-4			4.01	1.10	685	1,330
PP-FT50-5			4.03	1.15	590	1,030
Series Average						**1,080**
Standard Deviation						140
Coefficient of Variation (%)						13.0

- ***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	0
	Against Preceding Freeze-Thaw Exposure Set	+8.0

ASTM C666 – Post Freeze-Thaw Flexural Strength – 75-Cycle (Wet), Perpendicular Loading

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb_f)	Flexural Strength (psi)
No.	**Test Condition**		**Width**	**Depth**		
PP-FT75-1	Loaded perpendicular to stone rift plane Wet Condition	12.5	4.01	1.15	718	1,260
PP-FT75-2			4.01	1.09	442	860
PP-FT75-3			4.01	1.12	645	1,200
PP-FT75-4			4.01	1.13	621	1,150
PP-FT75-5			4.01	1.15	527	940
Series Average						**1,080**
Standard Deviation						173
Coefficient of Variation (%)						16.0

- ***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	0
	Against Preceding Freeze-Thaw Exposure Set	0

ASTM C666 – Post Freeze-Thaw Flexural Strength – 100-Cycle (Wet), Perpendicular Loading

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 Wet Condition	12.5	4.01	1.14	597	1,080
PP-FT100-2			4.01	1.13	397	730
PP-FT100-3			4.02	1.16	603	1,050
PP-FT100-4			4.01	1.14	424	770
PP-FT100-5			4.02	1.14	592	1,070
Series Average						**940**
Standard Deviation						174
Coefficient of Variation (%)						18.5

- ***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	-13.0
	Against Preceding Freeze-Thaw Exposure Set	-13.0

EN 12370 – Salt Crystallization Resistance Evaluation

Specimen No.	Measured Mass (g)		Mass Change (+/-)		Visual Observations
	Initial	Final	grams	%	
1	162.82	162.75	-0.07	-0.04	Condition Visibly Unaffected
2	164.38	164.30	-0.08	-0.05	Condition Visibly Unaffected
3	159.24	159.13	-0.11	-0.07	Condition Visibly Unaffected
4	155.13	155.21	+0.08	+0.05	Condition Visibly Unaffected
5	168.60	168.60	0.00	0.00	Condition Visibly Unaffected
6	155.32	155.36	+0.04	+0.03	Condition Visibly Unaffected
Series Average			**-0.02**	**-0.01**	
Standard Deviation			0.08	0.05	

Conclusions: The flexural test results were evaluated against the performance criteria presented in ASTM C1527, Table 1. The results of these evaluations are presented in the following table.

ASTM C1527 Performance Evaluation Summary					
Physical Requirement	**Test Series Detail**			**Result**	
				Mean Test Value	**Performance Evaluation**
C880 Flexural Strength (psi): Class I (Exterior): ≥500 Class II (Interior): ≥500	Perpendicular		Wet	1,080	Meets as Stated: Class I, II
	Perpendicular (Post ASTM C666 Freeze-Thaw Exposure)	25 Cycles	Wet	1,000	Meets as Stated: Class I, II
		50 Cycles		1,080	
		75 Cycles		1,080	
		100 Cycles		940	

Travertine Performance Evaluation

The Continental Buff Travertine product satisfied the ASTM C1527 performance requirements for Class II (Interior) and Class I (Exterior) for Flexural Strength both pre and post freeze-thaw exposure cycling.

Freeze-Thaw Durability Evaluation

There was no stated freeze-thaw performance requirement for travertine, so these results are reported as obtained and are summarized in the following table.

Post 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 Cycles	Loaded Perpendicular to the stone rift plane Wet Condition	1,080	*N/A*	*N/A*
25 Cycles		1,000	-7.4	*N/A*
50 Cycles		1,080	0	+8.0
75 Cycles		1,080	0	0
100 Cycles		940	-13.0	-13.0

No post-exposure freeze-thaw specimen showed readily visible signs of degradation post-exposure. While incremental post-exposure flexural strength values varied, the mean documented strength change between control series and post-100 exposure cycles was -13.0%. The flexural strength values appeared relatively stable throughout exposure cycling and the range of values observed are more likely due to variations between individual specimen matrices rather than any additional freeze-thaw exposure induced strength degradation.

EN12370 Salt Crystallization Resistance Evaluation:

There was no performance criteria provided for salt crystallization resistance, so results are reported as obtained. Test results are summarized in the following table.

Performance Evaluation Summary			
Physical Requirement	**Test Series Detail**	**Result**	
		Mean Test Value	**Performance Evaluation**
EN12370 Salt Crystallization Resistance (% Mass Change): N/A	Continental Buff Travertine	-0.02 %	Design property Only

No visible indications of degradation were observed in any post-exposure specimen. Further, as this exposure program is designed to be more aggressive than real-world installation conditions, the negligible mass loss recorded for the series is indicative of high resistance to salt crystallization induced degradation.

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.

Respectfully submitted,





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Revision Log

No.	Date	Page(s)	Description
0	04/26/25	N/A	Initial report release

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Photographs

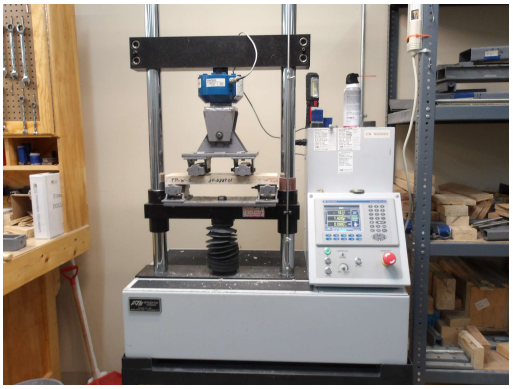


Photo No. 1
ASTM C880 – Flexural Strength Test Setup



Photo No. 2
ASTM C880 – Representative Load Application Detail

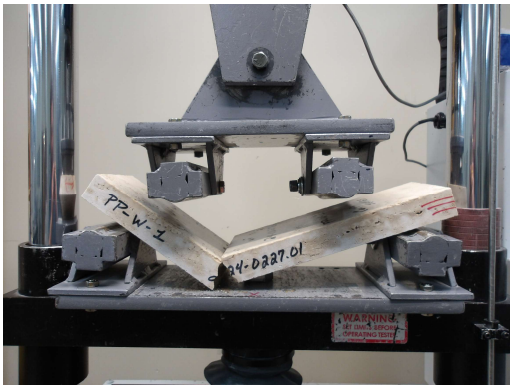


Photo No. 3
ASTM C880 – Representative Control Specimen Failure Mode (Perpendicular, Wet Condition)

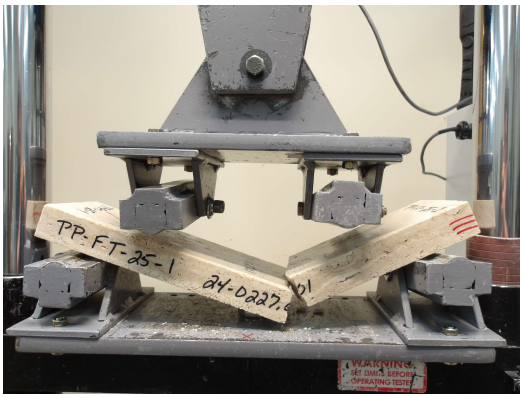


Photo No. 4
ASTM C666 – Representative Specimen Failure Mode (25-Cycle, Perpendicular, Wet Condition)

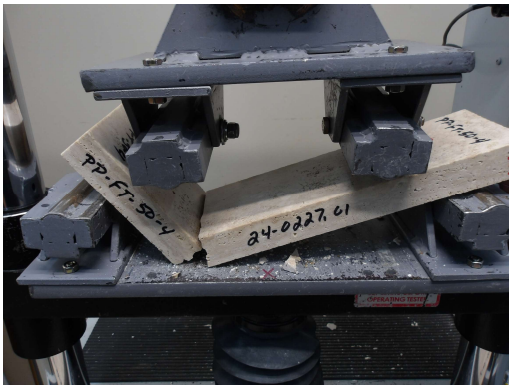


Photo No. 5
ASTM C666 – Representative Specimen Failure Mode (50-Cycle, Perpendicular, Wet Condition)

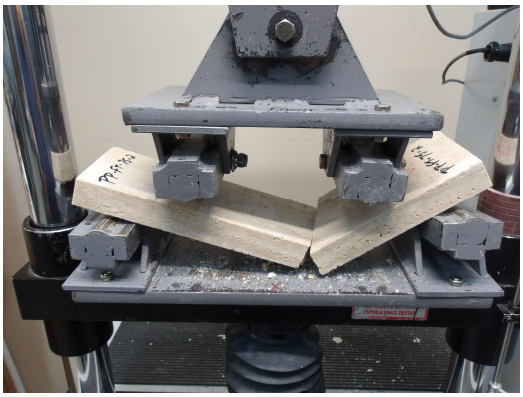


Photo No. 6
(ASTM C666 – Representative Specimen Failure Mode (75-Cycle, Perpendicular, Wet Condition)

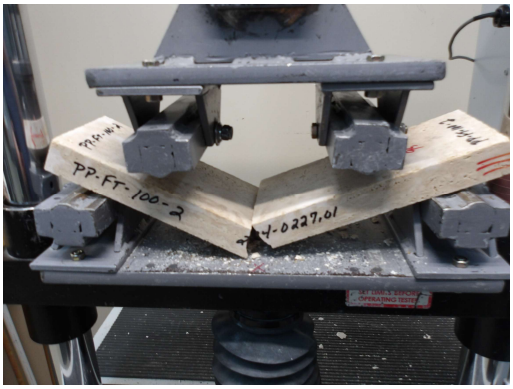


Photo No. 7
ASTM C666 – Representative Specimen Failure Mode (100-Cycle, Perpendicular, Wet Condition)

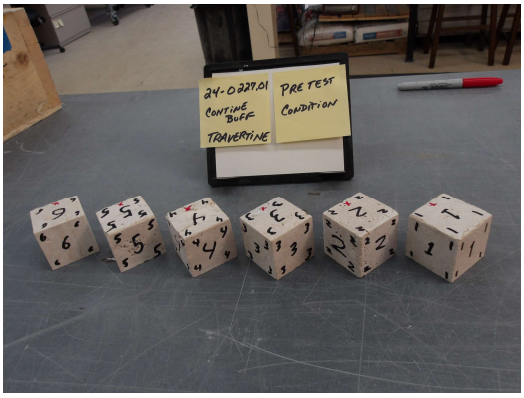


Photo No. 8
EN 12370 – Pretest Condition Specimens



Photo No. 9
EN 12370 – Test Setup
(Wet Condition)



Photo No. 10
EN 12370 – Post-Exposure Specimens Condition
(Visually non-Compromised)