



STONE LABORATORY TEST REPORT

Report No.: 22-0086.02-R1

Test Date(s): 10/21/22 – 12/06/22

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Prepared for: Brenda Buster
Lyons Sandstone
2493 CR 37E
Lyons, CO 80540

Product: One Sandstone Product – Milagro

Scope: The Natural Institute (NSI) was contracted by Lyons Sandstone to perform freeze-thaw durability evaluations for one natural Sandstone product (Milagro). The scope of testing included freeze-thaw exposure cycling and post-exposure comparative flexural strength evaluation. 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 C666/C666M-15, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

ASTM C880/C880M-18, Standard Test Method for Flexural Strength of Dimension Stone

Test Materials: Test materials were provided by Lyons Sandstone and were all received in good condition for testing. The stone specimens were designated as Milagro by the client. The stone submittal was provided in one rift orientation (Vein cut [running lengthwise]). Photographs of specimens as received are located on page 9. 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
R. Lawson	NSI
Mike Loflin	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 9-10 of this report. Equipment calibration certificates are available upon request.

ASTM C666 – Freeze-Thaw Resistance

The freeze-thaw exposure cycling was conducted in modified ESPEC EPX-4H environmental conditioning chamber (SN: 0140212) on in accordance with ASTM C666, Procedure B (Freeze-in-Air, That-in-Water). Specimens were oven-dried and weighed on an Ohaus digital balance (SN: B614316489) prior to being subjected to a total of 100 exposure cycles each consisting of the 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 pulled specimens were then oven dried and re-weighed prior to re-conditioning to wet condition and flexural testing as detailed the following section.

ASTM C880 – Flexural Strength

The Flexural strength evaluation was conducted on a ATS Universal Test Machine (SN: 16-14900-1) employing a 12.5-kip load cell (SN: 561414A) in accordance with the procedures detailed in ASTM C880. Control series (no exposure cycling) specimens were tested in both oven-dry and wet conditions. Post-exposure series specimens were tested after 25, 50, 75, and 100 cycle completion and in wet condition only. 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 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 were averaged for each test series and the post-exposure mean flexural strength of each exposure series was evaluated against the zero-cycle wet condition control series for determination of potential strength loss.

Specimen Details

Test Method	Quantity	Nominal Dimensions	Description
ASTM C666	Control (Dry): 5 Control (Wet): 5	4 in. x 15 in. x 1.0 in.	Medium Tan Natural Sandstone with Darker Tan Veining
ASTM C880 (Post-Exposure)	Post-25 Cycle: 5 Post-50 Cycle: 5 Post-75 Cycle: 5 Post-100 Cycle: 5		

Test Results

ASTM C666 – Post Exposure Visual Evaluation and Measured Mass Loss

Specimen Details		Visual Assessment	Mass			
			Measurements (g)		Loss	
No.	Test Condition		Initial	End	g	%
25-EW-1	Post 25-Cycle Oven Dry	No Visible Deterioration	2350.6	2347.8	2.8	0.12
25-EW-2		No Visible Deterioration	2405.2	2402.0	3.2	0.13
25-EW-3		No Visible Deterioration	2411.2	2408.5	2.7	0.11
25-EW-4		No Visible Deterioration	2411.6	2408.8	2.8	0.12
25-EW-5		No Visible Deterioration	2188.8	2185.9	2.9	0.13
Series Average						0.12
Standard Deviation						0.01
50-EW-1	Post 50-Cycle Oven Dry	No Visible Deterioration	2205.0	2202.5	2.5	0.11
50-EW-2		No Visible Deterioration	2395.4	2392.1	3.3	0.14
50-EW-3		No Visible Deterioration	2282.5	2280.2	2.3	0.10
50-EW-4		No Visible Deterioration	2387.3	2384.4	2.9	0.12
50-EW-5		No Visible Deterioration	2261.5	2258.9	2.6	0.11
Series Average						0.12
Standard Deviation						0.01
75-EW-1	Post 75-Cycle Oven Dry	No Visible Deterioration	2357.8	2355.8	2.0	0.08
75-EW-2		No Visible Deterioration	2307.0	2304.3	2.7	0.12
75-EW-3		No Visible Deterioration	2430.9	2428.5	2.4	0.10
75-EW-4		No Visible Deterioration	2472.2	2469.2	3.0	0.12
75-EW-5		No Visible Deterioration	2208.7	2206.1	2.6	0.12
Series Average						0.11
Standard Deviation						0.02
100-EW-1	Post 100-Cycle Oven Dry	No Visible Deterioration	2492.4	2489.7	2.7	0.11
100-EW-2		No Visible Deterioration	2350.5	2348.3	2.2	0.09
100-EW-3		No Visible Deterioration	2324.2	2322.1	2.1	0.09
100-EW-4		No Visible Deterioration	2382.0	2379.3	2.7	0.11
100-EW-5		No Visible Deterioration	2390.3	2381.5	8.8	0.37
Series Average						0.15
Standard Deviation						0.12

ASTM C880 – Flexural Strength – Control (Dry), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
C-ED-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	3.98	1.02	879	2,010
C-ED-2			3.97	1.07	1,049	2,170
C-ED-3			4.04	1.00	818	1,910
C-ED-4			3.99	0.98	1,058	2,570
C-ED-5			4.01	1.02	885	2,010
Series Average						2,130
Standard Deviation						261
Coefficient of Variation (%)						12.3

ASTM C880 – Flexural Strength – Control (Wet), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
C-EW-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	3.97	1.07	875	1,800
C-EW-2			3.97	1.02	759	1,710
C-EW-3			4.07	0.98	659	1,590
C-EW-4			3.96	1.01	832	1,920
C-EW-5			3.99	0.99	760	1,810
Series Average						1,770
Standard Deviation						123
Coefficient of Variation (%)						6.9

ASTM C880 – Flexural Strength – 25-Cycle (Wet), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
25-EW-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	3.92	1.00	863	2,050
25-EW-2			3.98	1.07	830	1,690
25-EW-3			4.01	1.03	854	1,890
25-EW-4			3.94	1.04	924	2,050
25-EW-5			4.02	0.94	636	1,680
Series Average						1,870
Standard Deviation						183
Coefficient of Variation (%)						9.8

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

ASTM C880 – Flexural Strength – 50-Cycle (Wet), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
50-EW-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	4.00	0.94	702	1,870
50-EW-2			4.04	1.00	904	2,100
50-EW-3			4.05	0.98	750	1,820
50-EW-4			4.03	0.99	835	1,970
50-EW-5			4.00	0.98	748	1,840
Series Average						1,920
Standard Deviation						116
Coefficient of Variation (%)						6.0

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

ASTM C880 – Flexural Strength – 75-Cycle (Wet), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb _f)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
75-EW-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	3.99	1.00	817	1,920
75-EW-2			4.00	1.00	771	1,820
75-EW-3			4.00	1.02	910	2,050
75-EW-4			3.99	1.11	923	1,760
75-EW-5			4.05	0.94	723	1,880
Series Average						1,890
Standard Deviation						110
Coefficient of Variation (%)						5.8

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

ASTM C880 – Flexural Strength – 100-Cycle (Wet), Load Perpendicular to Edge of Rift Plane

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb _f)	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
100-EW-1	Loaded Perpendicular to Edge of Stone Rift Plane Dry Condition	12.5	3.97	1.07	991	2,040
100-EW-2			4.06	0.98	730	1,760
100-EW-3			4.01	1.01	776	1,770
100-EW-4			3.99	1.02	771	1,750
100-EW-5			4.01	1.04	881	1,900
Series Average						1,840
Standard Deviation						125
Coefficient of Variation (%)						6.8

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

Conclusion: No performance criteria were provided for the Milagro natural sandstone product, so results are reported as obtained.

No readily visible signs of degradation were observed on any post-exposure Milagro test specimen.

A summary of comparative post-exposure flexural strength (wet condition post-exposure test series relative to wet condition control series) is included in the following table:

Post-Exposure Flexural Strength Evaluation Summary			
Test Series Designation	Test Condition	Result	
		Mean Flexural Strength (psi)	Exposure Series Performance Relative to Wet Control Series (%)
Control Series	Dry	2,130	N/A
	Wet	1,770	
Post-Exposure Series	25-Cycle (Wet)	1,870	+5.6
	50-Cycle (Wet)	1,920	+8.5
	75-Cycle (Wet)	1,890	+6.8
	100-Cycle (Wet)	1,840	+4.0

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	12/08/22	N/A	Initial report release
1	12/09/22	3	Editorial revision to mass loss data table

Document Control Number : NSI 00001 (07/07/22)

Photographs

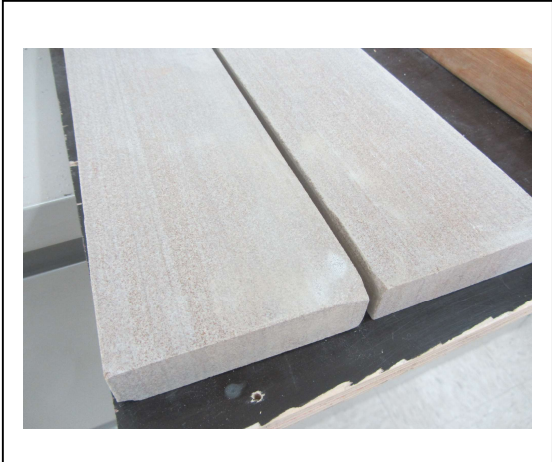


Photo No. 1
Representative Milagro Sandstone Specimen Condition Upon Receipt



Photo No. 2
Freeze-Thaw Evaluation Chamber

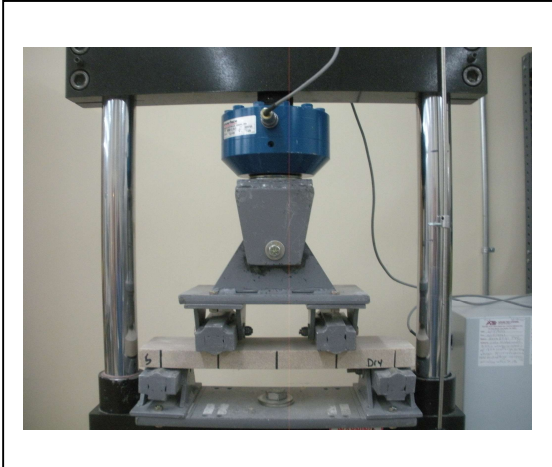


Photo No. 3
ASTM C880 – Flexural Strength Test Setup

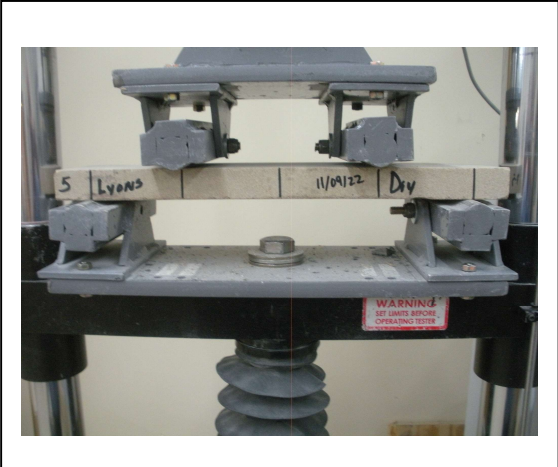


Photo No. 4
ASTM C880 – Specimen Loading Detail

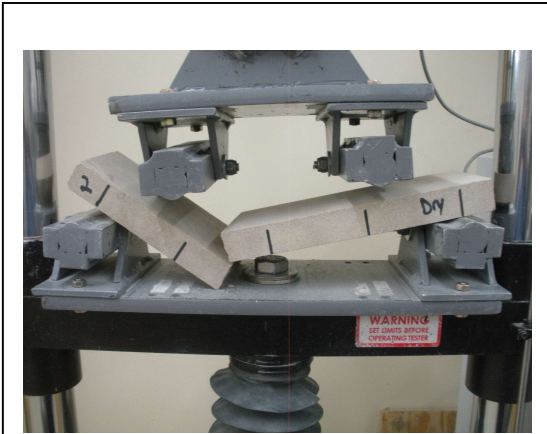


Photo No. 5
ASTM 880 – Representative Dry Condition
Specimen Failure Mode

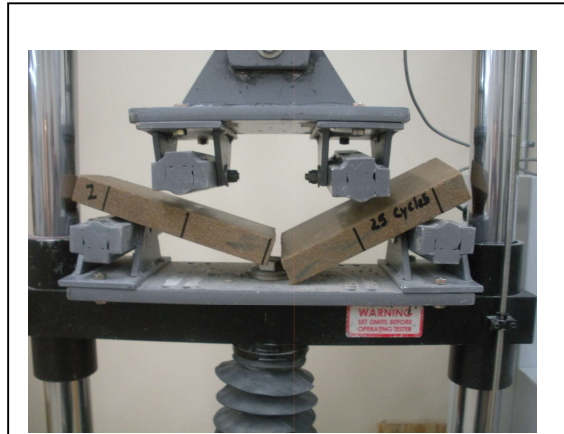


Photo No. 6
ASTM 880 – Representative Wet Condition
Specimen Failure Mode