



STONE LABORATORY TEST REPORT

Report No.: 21-0003.01-R0

Test Date(s): 08/18/22 – 08/31/22

Report Date: 09/01/22

Retention Date: 08/31/26

Prepared for: Mr. Bintao Qin
AM3 Stone
301 21st ST. N
Bessemer, AL 35020

Product: Natural Marble Product – Alabama White Marble

Scope: The Natural Institute (NSI) was contracted by AM3 Stone to perform physical properties evaluations for one natural marble product (Alabama White Marble). The scope of testing included absorption, density, compressive strength, Modulus of Rupture, Flexural Strength, and abrasion resistance. 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-2018, *Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone*

ASTM C170/C170M-2017, *Standard Test Method for Compressive Strength of Dimension Stone*

ASTM C99/C99M-18, *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*

ASTM C880/C880M-2018, *Standard Test Method for Flexural Strength of Dimension Stone*

ASTM C503/C503M-15, *Standard Specification for Marble Dimension Stone*

Test Materials: Test materials were provided by AM3 Stone and were received in good condition for testing other than the parallel loading orientation series C880 specimens (testing was performed at a modified support span in wet condition only for this test condition given the limited specimen availability). 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
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 12-14 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 oven-dried at 60°C to a stable mass condition (minimum 48 hours), reacclimated to ambient lab temperature and weighed on an Ohaus digital balance (SN: B614316489) for determination of dry condition mass. They were then immersed in filtered water for 48 hours prior to individual removal, surface drying with a damp cloth 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 series and evaluated against the performance criteria presented in ASTM C503, Table 1.

ASTM C170 – Compressive Strength Evaluation

The compressive strength evaluation was conducted on a Test Mark compression tester (SN: 160618) in accordance with the procedures detailed in ASTM C170. 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 the series and evaluated against the performance criteria presented in ASTM C503, Table 1.

ASTM C99 – Modulus of Rupture Evaluation

The Modulus of Rupture (MoR) 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 C99. 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 the series and evaluated against the performance criteria presented in ASTM C503, 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 C503, Table 1.

ASTM C880 – Flexural Strength Evaluation

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. 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 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 the series and evaluated against the performance criteria presented in ASTM C503, Table 1.

Deviation: As the parallel loading series C880 test specimens arrived majority damaged post-shipment, said specimens were only evaluated in wet condition and only one at the standard support and loading spans detailed above. The remaining four that were testable post-receipt were evaluated at a 10-inch support span (5 in. loading span).

Specimen Details

Test Method	Quantity	Nominal Dimensions	Description
ASTM C97	5	3 in. cubes	White Natural Marble with grey veining
ASTM C170	20	3 in. cubes	
ASTM C99	20	4 in. x 8 in. x 2.25 in.	
ASTM C880	15	4 in. x 15 in. x 1.25 in.	
ASTM C1353	3	4 in. square x 0.375 in.	

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	1,216.08	1,217.80	768.59	0.14	2.707	169.0
2	1,208.35	1,209.92	763.87	0.13	2.709	169.1
3	1,210.45	1,212.40	765.30	0.16	2.707	169.0
4	1,223.36	1,225.21	774.32	0.15	2.713	169.4
5	1,206.22	1,208.11	762.85	0.16	2.709	169.1
Series Average				0.15	2.709	169.1
Standard Deviation				0.0	0.0	0.2
Coefficient of Variation (%)				6.7	0.1	0.1

ASTM C1353 – Abrasion Resistance Evaluation

Specimen No.	Bulk Specific Gravity	Mass (g)			Wear Cycles Completed	Index of Abrasion
		Initial	End	Loss		
1	2.709	269.32	259.95	9.37	1,000	10.6
2		269.51	263.16	6.35		15.7
3		274.98	267.34	7.64		13.0
Series Average						13.1
Standard Deviation						2.5
Coefficient of Variation						19.3

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	Perpendicular to stone rift orientation	7.0	4.05	2.21	4,257	2,250
PP-W-2			4.04	2.26	4,435	2,260
PP-W-3			4.05	2.21	3,667	1,940
PP-W-4	Wet Condition		4.05	2.29	3,767	1,860
PP-W-5			4.08	2.20	3,731	1,990
Series Average						2,060
Standard Deviation						184
Coefficient of Variation (%)						8.9

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

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb _f)	Flexural Strength (psi)
			Width	Depth		
PP-D-1	Perpendicular to stone rift orientation	7.0	4.06	2.20	3,300	1,760
PP-D-2			4.06	2.22	4,066	2,130
PP-D-3			3.94	2.23	3,705	1,980
PP-D-4	Dry Condition		4.04	2.21	3,490	1,860
PP-D-5			4.05	2.21	3,274	1,740
Series Average						1,890
Standard Deviation						3
Coefficient of Variation (%)						8.6

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		
LL-W-1	Parallel to stone rift orientation Wet Condition	7.0	4.07	2.29	2,512	1,240
LL-W-2			4.07	2.30	2,439	1,190
LL-W-3			4.07	2.29	2,348	1,160
LL-W-4			4.06	2.31	2,582	1,250
LL-W-5			4.06	2.30	2,757	1,340
Series Average						1,240
Standard Deviation						69
Coefficient of Variation (%)						5.6

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

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb _f)	Flexural Strength (psi)
			Width	Depth		
LL-D-1	Parallel to stone rift orientation Dry Condition	7.0	4.06	2.30	3,220	1,570
LL-D-2			4.06	2.30	2,522	1,230
LL-D-3			4.07	2.29	3,084	1,510
LL-D-4			4.06	2.29	2,960	1,450
LL-D-5			4.07	2.30	2,668	1,300
Series Average						1,410
Standard Deviation						143
Coefficient of Variation (%)						10.1

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in²)	Failure Load (lbf)	Compressive Strength (psi)
		Length	Width			
PP-W-1	Perpendicular to stone rift orientation	3.03	3.01	9.10	134,380	14,770
PP-W-2		3.03	3.01	9.11	120,690	13,250
PP-W-3		3.00	3.03	9.08	136,320	15,010
PP-W-4	Wet Condition	3.00	3.04	9.11	132,840	14,580
PP-W-5		3.05	3.03	9.26	125,320	13,530
Series Average						14,230
Standard Deviation						786
Coefficient of Variation (%)						5.5

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in²)	Failure Load (lb _f)	Compressive Strength (psi)
		Length	Width			
PP-D-1	Perpendicular to stone rift orientation	3.01	3.01	9.05	121,100	13,380
PP-D-2		3.01	3.04	9.17	110,440	12,040
PP-D-3		3.02	3.00	9.05	140,030	15,470
PP-D-4	Dry Condition	3.01	3.02	9.08	115,220	12,690
PP-D-5		3.02	3.01	9.09	141,230	15,540
Series Average						13,820
Standard Deviation						1,606
Coefficient of Variation (%)						11.6

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in²)	Failure Load (lb _f)	Compressive Strength (psi)
		Length	Width			
LL-W-1	Parallel to stone rift orientation Wet Condition	3.00	3.04	9.14	95,050	10,400
LL-W-2		3.01	3.03	9.14	87,130	9,530
LL-W-3		3.03	3.02	9.13	96,810	10,600
LL-W-4		3.00	3.06	9.20	93,960	10,210
LL-W-5		3.00	3.04	9.11	76,700	8,420
Series Average						9,830
Standard Deviation						886
Coefficient of Variation (%)						9.0

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) ²
		Length	Width			
LL-D-1	Parallel to stone rift orientation Dry Condition	3.01	3.01	9.06	85,810	9,470
LL-D-1		3.01	3.00	9.04	118,820	13,140
LL-D-1		3.02	2.98	8.98	101,330	11,280
LL-D-1		3.02	2.98	8.99	92,010	10,230
LL-D-1		3.03	2.98	9.02	89,600	9,930
Series Average						10,810
Standard Deviation						1,463
Coefficient of Variation (%)						13.5

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	Perpendicular to stone rift orientation	12.5	4.08	1.21	1,084	1,710
PP-W-2			4.04	1.21	1,042	1,650
PP-W-3			4.04	1.25	1,209	1,800
PP-W-4	Wet Condition		4.05	1.27	1,183	1,690
PP-W-5			4.04	1.28	1,279	1,810
Series Average						1,730
Standard Deviation						70
Coefficient of Variation (%)						4.0

ASTM C880 – Flexural Strength Evaluation – Dry Condition, Perpendicular Loading

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb _f)	Flexural Strength (psi)
			Width	Depth		
PP-D-1	Perpendicular to stone rift orientation	12.5	4.04	1.21	1,071	1,700
PP-D-2			4.05	1.23	1,116	1,710
PP-D-3			4.04	1.23	1,062	1,630
PP-D-4	Dry Condition		4.04	1.25	1,068	1,580
PP-D-5			4.03	1.19	1,116	1,820
Series Average						1,690
Standard Deviation						91
Coefficient of Variation (%)						5.4

ASTM C880 – Flexural Strength Evaluation – Wet Condition, Parallel Loading

Specimen Details		Support Span (in) ¹	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi) ²
No.	Test Condition		Width	Depth		
LL-W-1	Parallel to stone rift orientation	10.0	4.05	1.25	426	500
LL-W-2			4.05	1.23	136	170
LL-W-3			4.06	1.30	990	1,090
LL-W-4			4.06	1.29	935	1,040
LL-W-5	Wet Condition	12.5	4.05	1.23	259	400
Series Average						640
Standard Deviation						406
Coefficient of Variation (%)						63.4

¹ Specimen 1-4 were tested at a 10 in. support span due to prism end fractures during shipping.

² Low performing specimens (Nos. LL-W-1, 2, 5) all fractured at a line of dark veining. See photo no. 10 for a representative example.

Conclusion: The test results were evaluated against the performance criteria presented in ASTM C503, Table 1. The results of this evaluation are presented in the table below:

ASTM C503 Performance Evaluation Summary				
Physical Requirement	Test Series Detail		Result	
			Mean Test Value	Class 1 Performance Evaluation
<u>C97 Absorption (%)</u>: Class I, Calcite: ≤ 0.20			0.15%	Meets as Stated
<u>C97 Density (lbs/ft³)</u>: Class I, Calcite: ≥ 162			169.1 lbs/ft ³	Meets as Stated
<u>C99 Modulus of Rupture (psi)</u>: Class I, Calcite: $\geq 1,000$	Perpendicular	Wet	2,060	Meets as Stated
		Dry	1,890	
	Parallel	Wet	1,240	
		Dry	1,410	
<u>C170 Compressive Strength (psi)</u>: Class I, Calcite: $\geq 7,500$	Perpendicular	Wet	14,230	Meets as Stated
		Dry	13,820	
	Parallel	Wet	9,830	
		Dry	10,810	
<u>C241 Abrasion Resistance:</u> Class I, Calcite: ≥ 10			13.1	Meets as Stated
<u>C880 Flexural Strength (psi)</u>: Class I, Calcite: $\geq 1,000$	Perpendicular	Wet	1,730	Meets as Stated
		Dry	1,690	
	Parallel	Wet	640	Fails to Meet as Stated
		Dry	N/A (Unavailable)	<i>Specimens damaged prior to testing</i>

The Alabama White Marble satisfied the ASTM C503 requirements for a Class I (Calcite) product for Absorption, Density, Modulus of Rupture, Compressive Strength, and Abrasion Resistance. The Alabama White Marble also satisfied the ASTM C503 requirements for a Class I (Calcite) product for Flexural Strength when loaded perpendicular to the stone rift orientation.

The Alabama White Marble failed to satisfy the ASTM C503 requirements for a Class I (Calcite) product for Flexural Strength when loaded parallel to the stone rift orientation (See photo no. 10) for a representative example.

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	09/01/22	N/A	Initial report release

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

Photographs

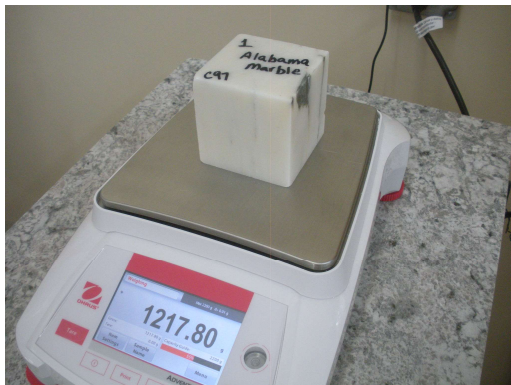


Photo No. 1
ASTM C97 – Test Apparatus

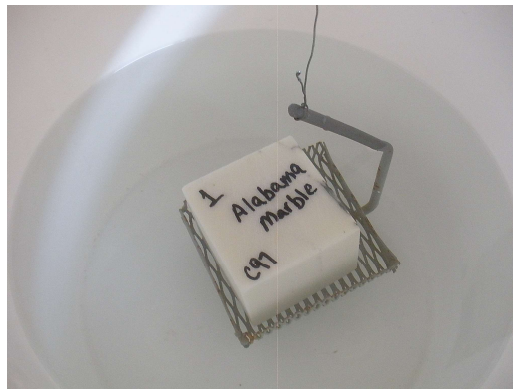


Photo No. 2
ASTM C97 – Suspended Mass
Determination Depicted

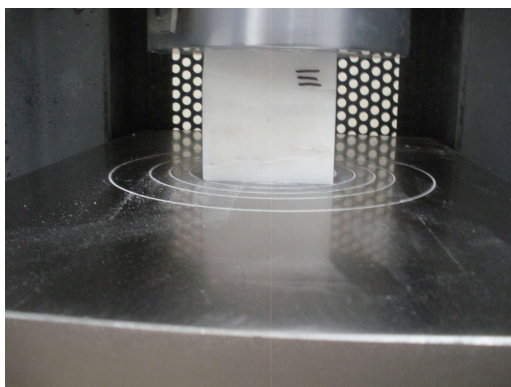


Photo No. 3
ASTM C170 – Pretest Condition Specimen



Photo No. 4
ASTM C170 – Representative Specimen
Failure Mode

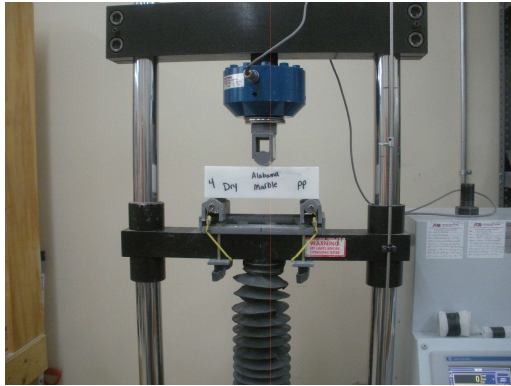


Photo No. 5
ASTM C99 – Test Setup



Photo No. 6
ASTM C99 – Representative Specimen
Failure Mode



Photo No. 7
ASTM C880 – Test Setup



Photo No. 8
ASTM C880 – Representative Specimen
Failure Mode



Photo No. 9

ASTM C880 – Low Performing Parallel Loading Specimen (No. LL-W-2) Fracture Plane Detail



Photo No. 10

ASTM C880 – Low Performing Parallel Loading Specimen (No. LL-W-4) Fracture Plane Detail



Photo No. 11

ASTM C1353 – Test Apparatus (Depicted with Pre-Abrasion Test Specimen)

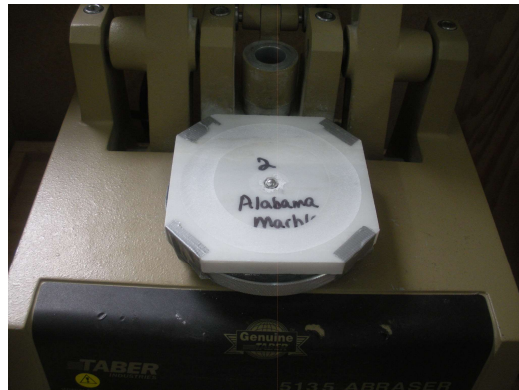


Photo No. 12

ASTM C1353 – Representative Post-Abrasion Specimen Condition