



**STONE LABORATORY TEST REPORT**

**Report No.:** 23-0085.01-R0

**Test Date(s):** 08/11/23 – 08/18/23

**Report Date:** 09/12/23

**Retention Date:** 08/18/27

**Prepared for:** Delaware River Basin Stone LLC  
1823 Airport Road  
Deposit, NY 13754

**Product:** New York Bluestone

**Scope:** The Natural Institute (NSI) was contracted by Delaware River Basin Stone LLC to perform physical properties evaluations for one natural Sandstone product (New York Bluestone). The scope of testing included absorption, density, compressive strength, modulus of rupture, abrasion resistance, flexural strength, and Dynamic Coefficient of Friction. 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-17, 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 C616/C616M-22, Standard Specification for Quartz-Based Dimension Stone*

*ASTM C880/C880M-18e1, Standard Test Method for Flexural Strength of Dimension Stone*

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

determination of dry condition mass. They were then immersed at 22°C temperature (verified by an Omega HH509R Thermometer) for 24 hours prior to individual specimen removal, surface drying to constant mass. The specimens were then suspended in the water with a known mass for determination of immersed condition mass. Absorption (%) and bulk density were calculated for each specimen as per the equations in ASTM C97, Section 9.1. The results were compared and evaluated against the performance criteria present in the specification.

### Compressive Strength Evaluation

Compressive strength evaluation was conducted on a Test Mark compression testing machine in accordance with the procedures detailed in ASTM C170. Pretest specimen dimensions were measured with a 6" x 0.0005" Digital Caliper (SN: B22206393). Specimens were tested under both dry and wet conditions. Dry condition specimens were oven-dried to constant mass for 24 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. The results were compared and evaluated against the performance criteria present in the specification.

**ASTM C99 – Modulus of Rupture Evaluation**

The Modulus of Rupture (MoR) evaluation was conducted on an 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. Pretest specimen dimensions were measured with a 6" x 0.0005" Digital Caliper (SN: B22206393). 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 C616, 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 C616, Table 1 as well as the provided project specification.

**ASTM C880 – Flexural Strength Evaluation**

The Flexural strength evaluation was conducted on an 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. Pretest specimen dimensions were measured with a 6" x 0.0005" Digital Caliper (SN: B22206393). 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.

**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 8 & 9. Specimens were evaluated with a BOT 3000E tribometer (ICN: NSI00002) in wet condition (employing a 0.05% SLS solution). Four travel passes were taken at a 90° offset to one another and the resultant DCoF measurements averaged for each specimen. Mean 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.

**Specimen Details**

Test Method	Quantity	Nominal Dimensions	Description
ASTM C97	5	2.25 in. cubes	Medium blue/grey tone natural Bluestone (Sandstone) product
ASTM C170	20 Total  Indeterminate, Finished Face Loading, Wet: 5 Indeterminate, Finished Face Loading, Dry: 5 Indeterminate, Side Loading Wet: 5 Indeterminate, Side Loading Dry: 5	2.25 in. cubes	
ASTM C99	20 Total  Indeterminate, Wet: 10 Indeterminate, Dry: 10	4 in. x 8 in. x 2.25 in. thickness	
ASTM C1353	3	4 in. square x 0.375 in. thickness	
ASTM C880	20 Total  Indeterminate, Wet: 10 Indeterminate, Dry: 10	4 in. x 15 in. x 1.25 in. thickness	
ANSI A326.3	3	12 in. square x 2.0 in. thickness	

## Test Results

## ASTM C97 – Absorption &amp; Density – New York Bluestone

Specimen No.	Measured Mass (g)			Absorption (%)	Bulk Specific Gravity	Density (lbs/ft <sup>3</sup> )
	Oven-Dry	48-Hour Wetted	Immersed Suspended			
1	478.67	484.86	301.46	1.29	2.610	162.9
2	477.08	483.15	300.66	1.27	2.614	163.2
3	477.80	483.86	301.13	1.27	2.615	163.2
4	474.18	480.12	298.86	1.25	2.616	163.3
5	478.94	484.99	301.79	1.26	2.614	163.2
<b>Series Average</b>				<b>1.27</b>	<b>2.614</b>	<b>163.2</b>
<b>Standard Deviation</b>				0.01	0.002	0.2
<b>Coefficient of Variation (%)</b>				0.8	0.1	0.1

## ASTM C1353 – Abrasion Resistance – New York Bluestone

Specimen No.	Bulk Specific Gravity	Mass (g)			Wear Cycles Completed	Index of Abrasion
		Initial	End	Loss		
1	2.61	268.44	266.89	1.55	1,000	62.0
2		262.16	260.62	1.54		62.4
3		266.69	265.18	1.51		63.6
<b>Series Average</b>						<b>62.7</b>
<b>Standard Deviation</b>						0.9
<b>Coefficient of Variation (%)</b>						1.4

## ANSI A326.3 - Dynamic Coefficient of Friction (Wet) – New York Bluestone (Thermal Finish)

Specimen No.	Test Orientation				Wet Condition DCoF
	0°	90°	180°	270°	
1	0.79	0.79	0.79	0.79	<b>0.79</b>
2	0.76	0.78	0.77	0.78	<b>0.77</b>
3	0.79	0.81	0.80	0.82	<b>0.81</b>
<b>Series Average</b>					<b>0.79</b>
<b>Standard Deviation</b>					0.02
<b>Coefficient of Variation (%)</b>					2.1

**ASTM C170 – Compressive Strength – New York Bluestone, Test Condition: WET**

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
I(F)-W-1	Indeterminate stone rift orientation (Finished Face Loading) Wet Condition	2.24	2.23	4.98	63,120	12,670
I(F)-W-2		2.23	2.24	4.99	54,490	10,920
I(F)-W-3		2.24	2.23	4.99	52,720	10,570
I(F)-W-4		2.23	2.23	4.97	62,700	12,620
I(F)-W-5		2.23	2.23	4.98	55,720	11,190
<b>Series Average</b>						<b>11,590</b>
<b>Standard Deviation</b>						984
<b>Coefficient of Variation (%)</b>						8.5

**ASTM C170 – Compressive Strength – New York Bluestone, Test Condition: DRY**

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
I(F)-D-1	Indeterminate stone rift orientation (Finished Face Loading) Dry Condition	2.23	2.23	4.97	66,040	13,290
I(F)-D-2		2.25	2.24	5.06	68,800	13,600
I(F)-D-3		2.26	2.23	5.04	73,140	14,510
I(F)-D-4		2.23	2.23	4.98	72,350	14,530
I(F)-D-5		2.23	2.23	4.96	76,590	15,440
<b>Series Average</b>						<b>14,270</b>
<b>Standard Deviation</b>						852
<b>Coefficient of Variation (%)</b>						6.0

**ASTM C170 – Compressive Strength – New York Bluestone, Test Condition: WET**

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
I(S)-W-1	Indeterminate stone rift orientation (Side Face Loading)  Wet Condition	2.29	2.23	5.09	79,540	15,630
I(S)-W-2		2.29	2.23	5.09	69,730	13,700
I(S)-W-3		2.29	2.23	5.10	69,270	13,580
I(S)-W-4		2.27	2.23	5.05	68,640	13,590
I(S)-W-5		2.27	2.23	5.04	69,110	13,710
<b>Series Average</b>						<b>14,040</b>
<b>Standard Deviation</b>						890
<b>Coefficient of Variation (%)</b>						6.3

**ASTM C170 – Compressive Strength – New York Bluestone, Test Condition: DRY**

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
I(S)-D-1	Indeterminate stone rift orientation (Side Face Loading)  Dry Condition	2.28	2.23	5.07	76,800	15,150
I(S)-D-2		2.27	2.23	5.06	69,610	13,760
I(S)-D-3		2.29	2.23	5.10	99,130	19,440
I(S)-D-4		2.26	2.22	5.03	102,140	20,310
I(S)-D-5		2.33	2.22	5.19	97,060	18,700
<b>Series Average</b>						<b>17,470</b>
<b>Standard Deviation</b>						2,855
<b>Coefficient of Variation (%)</b>						16.3

**ASTM C99 – Modulus of Rupture – New York Bluestone, Test Condition: WET**

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Modulus of Rupture (psi)
No.	Load Application Relative to Rift Orientation		Width	Depth		
I-W-1	Indeterminate stone rift orientation  Wet Condition	7.0	4.02	2.16	4,482	2,520
I-W-2			4.01	2.16	3,990	2,230
I-W-3			4.00	2.14	3,877	2,220
I-W-4			4.00	2.14	3,931	2,260
I-W-5			3.98	2.15	4,061	2,310
I-W-6			4.03	2.15	4,326	2,430
I-W-7			4.01	2.15	4,202	2,380
I-W-8			3.98	2.13	4,123	2,390
I-W-9			4.00	2.18	4,269	2,360
I-W-10			4.01	2.17	4,276	2,390
<b>Series Average</b>						<b>2,350</b>
<b>Standard Deviation</b>						95
<b>Coefficient of Variation (%)</b>						4.0

**ASTM C99 – Modulus of Rupture – New York Bluestone, Test Condition: DRY**

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Modulus of Rupture (psi)
No.	Load Application Relative to Rift Orientation		Width	Depth		
I-D-1	Indeterminate stone rift orientation  Dry Condition	7.0	3.99	2.10	4,537	2,690
I-D-2			3.97	2.10	4,776	2,860
I-D-3			3.99	2.12	4,536	2,650
I-D-4			3.96	2.08	4,595	2,820
I-D-5			3.98	2.17	4,644	2,610
I-D-6			3.99	2.13	4,559	2,640
I-D-7			3.98	2.12	4,534	2,670
I-D-8			4.00	2.12	4,942	2,880
I-D-9			3.98	2.13	4,971	2,880
I-D-10			3.96	2.12	5,102	3,000
<b>Series Average</b>						<b>2,770</b>
<b>Standard Deviation</b>						134
<b>Coefficient of Variation (%)</b>						4.8

**ASTM C880 – Flexural Strength – New York Bluestone, Test Condition: WET**

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Load Application Relative to Rift Orientation		Width	Depth		
I-W-1	Indeterminate stone rift orientation  Wet Condition	12.5	3.98	1.26	1,182	1,750
I-W-2			3.98	1.29	1,247	1,760
I-W-3			3.98	1.29	1,335	1,880
I-W-4			3.99	1.30	790	1,100
I-W-5			3.98	1.29	1,218	1,720
I-W-6			3.98	1.25	1,321	2,000
I-W-7			3.98	1.24	1,090	1,670
I-W-8			3.97	1.27	1,192	1,740
I-W-9			4.02	1.28	1,307	1,860
I-W-10			3.98	1.27	1,238	1,800
<b>Series Average</b>						<b>1,730</b>
<b>Standard Deviation</b>						240
<b>Coefficient of Variation (%)</b>						13.9

**ASTM C880 – Flexural Strength – New York Bluestone, Test Condition: DRY**

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lbf)	Flexural Strength (psi)
No.	Load Application Relative to Rift Orientation		Width	Depth		
I-D-1	Indeterminate stone rift orientation  Dry Condition	12.5	4.04	1.27	1,631	2,340
I-D-2			3.98	1.23	1,634	2,530
I-D-3			4.00	1.28	1,630	2,340
I-D-4			3.99	1.29	1,509	2,130
I-D-5			4.02	1.27	1,573	2,270
I-D-6			4.01	1.28	1,525	2,190
I-D-7			4.00	1.30	1,575	2,170
I-D-8			3.96	1.29	1,623	2,310
I-D-9			3.98	1.29	1,647	2,330
I-D-10			3.98	1.29	1,586	2,250
<b>Series Average</b>						<b>2,290</b>
<b>Standard Deviation</b>						114
<b>Coefficient of Variation (%)</b>						5.0

**Conclusion:** The average test results were evaluated against the performance criteria presented in ASTM C616 Table 1, and ANSI A326.3. The results of these evaluations are presented in the table(s) below:

<b>ASTM C616 Quartz-Based Stone Performance Evaluation Summary</b>				
<b>Physical Requirement</b>	<b>Test Series Detail</b>		<b>Result</b>	
			<b>Mean Test Value</b>	<b>Performance Evaluation</b>
<b>C97 Absorption (%):</b> Class I (Sandstone): $\leq 8.0$ Class II (Quartzitic Sandstone): $\leq 3.0$ Class III (Quartzite): $\leq 1.0$			1.27	Meets as Stated: Class II
<b>C97 Density (lbs/ft<sup>3</sup>):</b> Class I (Sandstone): $\geq 125$ Class II (Quartzitic Sandstone): $\geq 150$ Class III (Quartzite): $\geq 160$			163.2	Meets as Stated: Class III
<b>C170 Compressive Strength (psi):</b> Class I (Sandstone): $\geq 4,000$ Class II (Quartzitic Sandstone): $\geq 10,000$ Class III (Quartzite): $\geq 20,000$	Indeterminate (Face Loading)	Wet	11,590	Meets as Stated: Class II
		Dry	14,270	
	Indeterminate (Side Loading)	Wet	14,040	
		Dry	17,470	
<b>C99 Modulus of Rupture (psi):</b> Class I (Sandstone): $\geq 350$ Class II (Quartzitic Sandstone): $\geq 1,000$ Class III (Quartzite): $\geq 2,000$	Indeterminate	Wet	2,350	Meets as Stated: Class III
		Dry	2,770	
<b>C1353 Abrasion Resistance:</b> Class I (Sandstone): $H_a \geq 2$ Class II (Quartzitic Sandstone): $H_a \geq 8$ Class III (Quartzite): $H_a \geq 8$			62.7	Meets as Stated: Class III
<b>C880 Flexural Strength (psi):</b> No Performance Criteria Stated	Indeterminate	Wet	1,730	Design Property Only
		Dry	2,290	

<b>ANSI A326.3 Performance Evaluation Summary</b>			
<b>Physical Requirement</b>	<b>Test Series Detail</b>	<b>Result</b>	
		<b>Mean Test Value</b>	<b>Performance Evaluation</b>
<b>ANSI A326.3 - Dynamic Coefficient of Friction (Wet):</b> DCoF $\geq$ 0.42	Thermal Finish	0.79	Meets as Stated

#### **ASTM C616 – Sandstone Properties Evaluation**

The New York Bluestone product satisfied the ASTM C616 performance requirements for a Class II (Quartzitic Sandstone) product.

There are no ASTM C616 performance criteria for ASTM C880 Flexural Strength, so these values are reported as a design property only.

#### **ANSI A326.3 – Dynamic Coefficient of Friction Evaluation**

The New York Bluestone product satisfied the ANSI A326.3 recommended minimum wet condition performance criteria of 0.42 DCoF for the provided finish submittal (Thermal Finish: 0.79).

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,



Scott D. Scallorn, Testing Lab Manager

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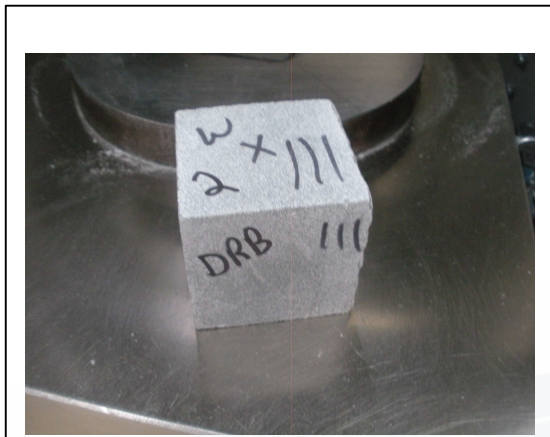
Email: [scott@naturalstoneinstitute.org](mailto:scott@naturalstoneinstitute.org)

**Revision Log**

No.	Date	Page(s)	Description
0	09/12/23	N/A	Initial report release

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

**Photographs**



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



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



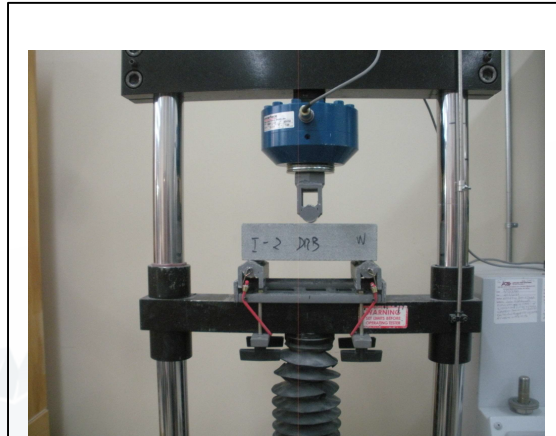
**Photo No. 3**  
ASTM C170 – Specimen Failure Mode:  
Indeterminate Stone Rift, Side Loading  
(Dry Condition Depicted)



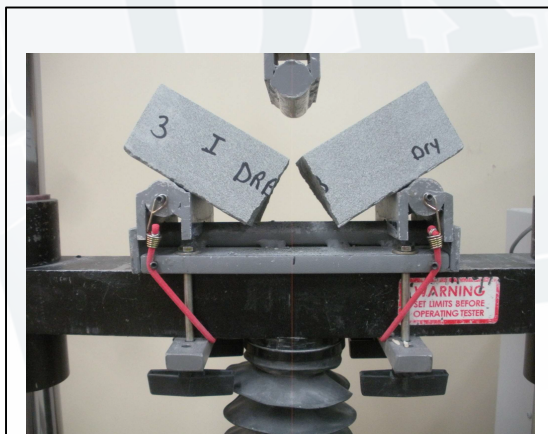
**Photo No. 4**  
ASTM C170 – Specimen Failure Mode:  
Indeterminate Stone Rift, Face Loading  
(Wet Condition Depicted)



**Photo No. 5**  
ASTM C97 – Absorption & Density Test Setup



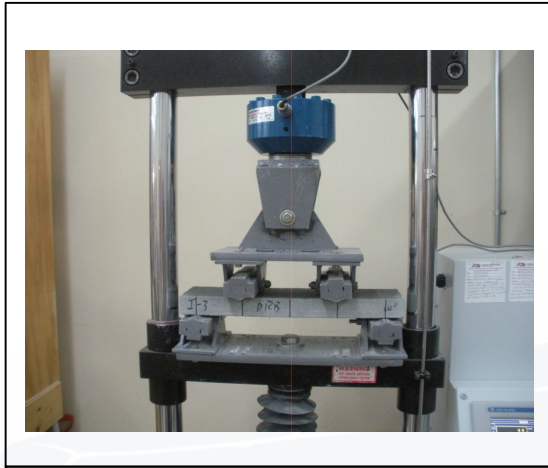
**Photo No. 6**  
ASTM C99 – Modulus of Rupture Test Setup



**Photo No. 7**  
ASTM C99 – Specimen Failure Mode:  
Indeterminate Stone Rift  
(Dry Condition)



**Photo No. 8**  
ASTM C99 – Specimen Failure Mode:  
Indeterminate Stone Rift  
(Wet Condition)



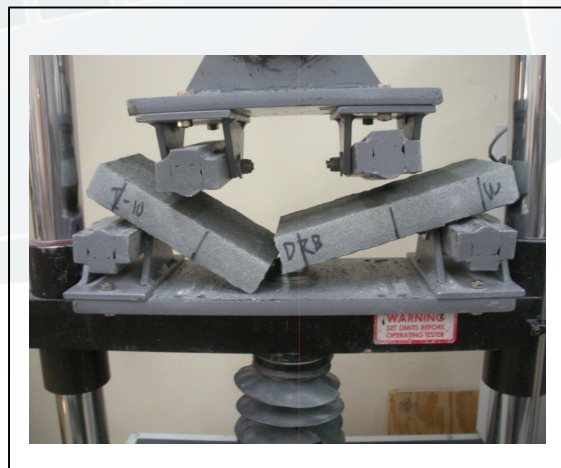
**Photo No. 9**  
ASTM C880 – Flexural Strength Test Setup



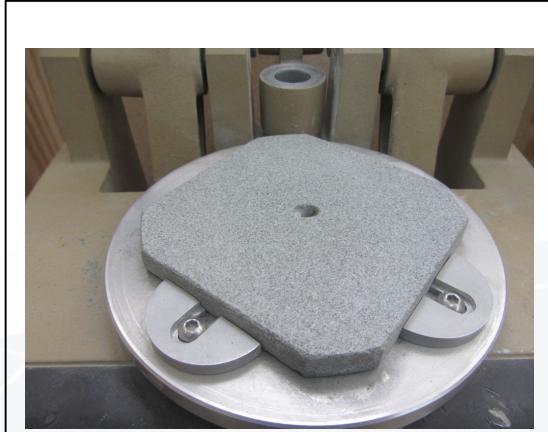
**Photo No. 10**  
ASTM C880 – Specimen Loading Detail



**Photo No. 11**  
ASTM C880 – Specimen Failure Mode:  
Indeterminate Stone Rift  
(Dry Condition)



**Photo No. 12**  
ASTM C880 – Specimen Failure Mode:  
Indeterminate Stone Rift  
(Wet Condition)



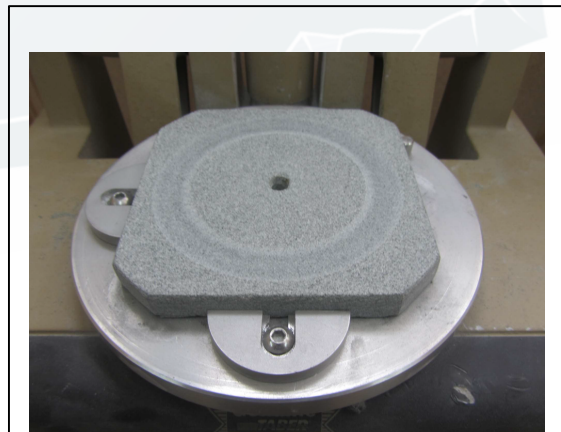
**Photo No. 13**  
ASTM C1353 – Representative Pretest  
Specimen Condition



**Photo No. 14**  
ASTM C1353 – Abrasion Test Setup



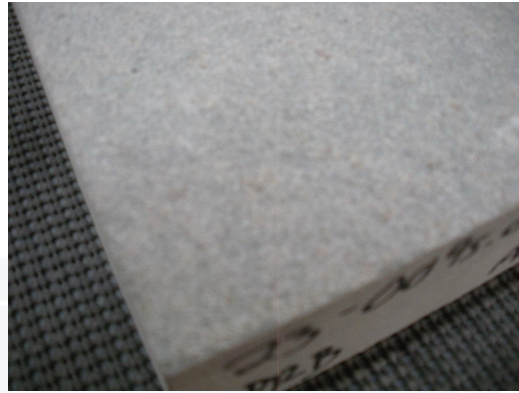
**Photo No. 15**  
ASTM C1353 – Test in Progress



**Photo No. 16**  
ASTM C1353 – Representative Post-  
Abrasion Specimen Condition



**Photo No. 17**  
BOT 3000E Test Apparatus



**Photo No. 18**  
New York Bluestone Surface Detail  
(Thermal Finish)



**Photo No. 19**  
ANSI A326.3 – DCoF Test Set Up



**Photo No. 20**  
ANSI A326.3 – Test in Progress