



**STONE LABORATORY TEST REPORT**

**Report No.:** 22-0082.01-R0

**Test Date(s):** 09/26/22 – 09/29/22

**Report Date:** 12/12/22

**Revision Date:** 01/19/23

**Retention Date:** 09/29/26

**Prepared for:** Mr. Justin Lindblad  
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1432 Teton  
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**Product:** 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 absorption, density, compressive strength, modulus of rupture, flexural strength, abrasion resistance, slip resistance (dynamic coefficient of friction [DCoF]), and petrographic analysis. 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 C880/C880M-2018**, *Standard Test Method for Flexural Strength 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 C1527/C1527M-11(2018)**, *Standard Specification for Travertine Dimension Stone*

**ASTM C99/C99M-18**, *Standard Test Method for Modulus of Rupture of Dimension Stone*

**ANSI A326.3-2018**, *American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials*

**ASTM C1721-21a**, *Standard Guide for Petrographic Examination of Dimension Stone*

**Test Materials:** Test materials were provided by Yellowstone Rock (submitted via Idaho Falls, ID.) and were received in good condition for testing. 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**

<b>Name</b>	<b>Company</b>
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 14-16 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 C1527, 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 C1527, 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 C1527, 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 C1527, 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.

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

The DCoF evaluation was conducted in accordance with the procedures detailed in ANSI A326.3, section 8. Specimens were evaluated with a BOT 3000E tribometer (Serial No.: VS 901265800196) in wet condition (employing a 0.05% SLS solution). Four 10 in. long 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.

**ASTM C1721 - Petrographic Evaluation**

The petrographic analysis was performed in accordance with ASTM C1721 by a qualified outsource laboratory (Minerology, Inc.). The full report is designated as “22342.ID\_Travertine” and was reported independently.

**Specimen Details**

Test Method	Quantity	Nominal Dimensions	Description
ASTM C97	5	3.0 in. cubes	Cream tone natural travertine
ASTM C170	20	3.0 in. cubes	
ASTM C880	20	4 in. x 15 in. x 1.25 in.	
ASTM C1353	3	4 in. square x 0.375 in.	
ASTM C99	20	4 in. x 8 in. x 2.25 in.	
ANSI A326.3	3	12 in. square x 0.375 in.	
ASTM C1721	1	4 in. square x 1.25 in.	

**Test Results****ASTM C97 – Absorption & Density Evaluation**

Specimen No.	Measured Mass (g)			Absorption (%)	Bulk Specific Gravity	Density (lbs/ft <sup>3</sup> )
	Oven-Dry	48-Hour Wetted	Immersed Suspended			
1	1,149.39	1,156.98	703.63	0.66	2.535	158.3
2	1,115.11	1,125.61	673.44	0.94	2.466	153.9
3	1,108.36	1,118.82	669.28	0.94	2.466	153.9
4	1,153.56	1,159.17	706.78	0.49	2.550	159.2
5	1,140.84	1,151.56	692.02	0.94	2.483	155.0
<b>Series Average</b>				<b>0.79</b>	<b>2.500</b>	<b>156.1</b>
<b>Standard Deviation</b>				0.2	0.04	2.5
<b>Coefficient of Variation (%)</b>				26.6	1.6	1.6

**ASTM C1353 – Abrasion Resistance Evaluation**

Specimen No.	Bulk Specific Gravity	Mass (g)			Wear Cycles Completed	Index of Abrasion
		Initial	End	Loss		
1	2.500	204.22	195.85	8.37	1,000	11.0
2		210.77	202.94	7.83		11.7
3		203.78	191.60	12.18		7.5
<b>Series Average</b>						<b>10.1</b>
<b>Standard Deviation</b>						2.2
<b>Coefficient of Variation (%)</b>						22.1

**ANSI A326.3 - Dynamic Coefficient of Friction (Wet)**

Specimen No.	Test Orientation				Wet Condition
	0°	90°	180°	270°	DCoF
1	0.76	0.76	0.77	0.79	0.77
2	0.74	0.76	0.74	0.76	0.75
3	0.81	0.79	0.78	0.83	0.80
<b>Series Average</b>					<b>0.77</b>
<b>Standard Deviation</b>					0.03
<b>Coefficient of Variation (%)</b>					3.5

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
PP-W-1	Perpendicular to stone rift orientation  Wet Condition	3.06	3.02	9.24	132,100	14,300
PP-W-2		3.05	3.03	9.24	130,400	14,110
PP-W-3		3.06	3.03	9.27	138,600	14,950
PP-W-4		3.06	3.03	9.27	106,900	11,530
PP-W-5		3.00	3.05	9.15	131,000	14,320
<b>Series Average</b>						<b>13,840</b>
<b>Standard Deviation</b>						1,331
<b>Coefficient of Variation (%)</b>						9.6

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
PP-D-1	Perpendicular to stone rift orientation  Dry Condition	3.02	3.05	9.21	111,000	12,050
PP-D-2		3.05	3.02	9.21	134,600	14,610
PP-D-3		3.04	3.02	9.18	124,400	13,550
PP-D-4		3.03	3.05	9.24	87,900	9,510
PP-D-5		3.03	3.05	9.24	91,100	9,860
<b>Series Average</b>						<b>11,920</b>
<b>Standard Deviation</b>						2,234
<b>Coefficient of Variation (%)</b>						18.7

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi)
		Length	Width			
LL-W-1	Parallel to stone rift orientation  Wet Condition	3.07	3.05	9.36	98,100	10,480
LL-W-2		3.02	3.03	9.15	96,500	10,550
LL-W-3		3.06	3.02	9.24	121,800	13,180
LL-W-4		3.06	3.04	9.30	125,200	13,460
LL-W-5		3.03	3.07	9.30	113,900	12,250
<b>Series Average</b>						<b>11,980</b>
<b>Standard Deviation</b>						1,414
<b>Coefficient of Variation (%)</b>						11.8

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

Specimen No.	Test Condition	Specimen Dimensions (in)		Loading Area (in <sup>2</sup> )	Failure Load (lb <sub>f</sub> )	Compressive Strength (psi) <sup>2</sup>
		Length	Width			
LL-D-1	Parallel to stone rift orientation  Dry Condition	3.02	3.02	9.12	112,900	12,380
LL-D-1		3.01	3.02	9.09	96,000	10,560
LL-D-1		3.06	3.05	9.33	94,700	10,150
LL-D-1		3.06	3.02	9.24	124,300	13,450
LL-D-1		3.02	3.03	9.15	136,100	14,870
<b>Series Average</b>						<b>1,2280</b>
<b>Standard Deviation</b>						1,974
<b>Coefficient of Variation (%)</b>						9.6

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

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
PP-W-1	Perpendicular to stone rift orientation Wet Condition	12.5	4.01	1.25	660	990
PP-W-2			4.00	1.25	610	920
PP-W-3			4.00	1.26	660	970
PP-W-4			4.01	1.25	640	960
PP-W-5			4.01	1.25	580	870
<b>Series Average</b>						<b>940</b>
<b>Standard Deviation</b>						48
<b>Coefficient of Variation (%)</b>						5.1

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

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Flexural Strength (psi)
			Width	Depth		
PP-D-1	Perpendicular to stone rift orientation Dry Condition	12.5	4.02	1.25	780	1,160
PP-D-2			4.01	1.26	630	930
PP-D-3			4.01	1.25	780	1,170
PP-D-4			4.01	1.25	800	1,200
PP-D-5			3.99	1.25	850	1,280
<b>Series Average</b>						<b>1,150</b>
<b>Standard Deviation</b>						0.9
<b>Coefficient of Variation (%)</b>						11.4

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

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
LL-W-1	Parallel to stone rift orientation Wet Condition	12.5	4.01	1.26	230	340
LL-W-2			4.01	1.27	300	430
LL-W-3			4.01	1.27	670	970
LL-W-4			4.02	1.25	710	1,060
LL-W-5			4.00	1.27	500	730
<b>Series Average</b>						<b>710</b>
<b>Standard Deviation</b>						318
<b>Coefficient of Variation (%)</b>						44.8

**ASTM C880 – Flexural Strength Evaluation – Dry Condition, Parallel Loading**

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>f</sub> )	Flexural Strength (psi)
No.	Test Condition		Width	Depth		
LL-D-1	Parallel to stone rift orientation Wet Condition	12.5	4.01	1.25	760	1,140
LL-D-2			4.01	1.26	260	380
LL-D-3			4.01	1.26	60	90
LL-D-4			4.01	1.26	480	710
LL-D-5			4.02	1.27	400	580
<b>Series Average</b>						<b>580</b>
<b>Standard Deviation</b>						391
<b>Coefficient of Variation (%)</b>						67.4



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

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>r</sub> )	Modulus of Rupture (psi)
No.	Test Condition		Width	Depth		
PP-W-1	Perpendicular to stone rift orientation Wet Condition	7.0	4.01	2.27	3,016	1,530
PP-W-2			4.00	2.28	2,816	1,420
PP-W-3			4.03	2.28	2,906	1,460
PP-W-4			4.00	2.27	2,595	1,320
PP-W-5			4.00	2.28	3,173	1,600
<b>Series Average</b>						<b>1,470</b>
<b>Standard Deviation</b>						107
<b>Coefficient of Variation (%)</b>						7.3

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

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>r</sub> )	Flexural Strength (psi)
			Width	Depth		
PP-D-1	Perpendicular to stone rift orientation Dry Condition	7.0	4.00	2.27	3,000	1,530
PP-D-2			4.00	2.26	2,997	1,540
PP-D-3			4.01	2.27	3,427	1,740
PP-D-4			4.00	2.26	2,489	1,280
PP-D-5			4.00	2.26	2,671	1,370
<b>Series Average</b>						<b>1,490</b>
<b>Standard Deviation</b>						177
<b>Coefficient of Variation (%)</b>						11.9

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

Specimen Details		Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>r</sub> )	Modulus of Rupture (psi)
No.	Test Condition		Width	Depth		
LL-W-1	Parallel to stone rift orientation  Wet Condition	7.0	4.21	2.49	2,366	950
LL-W-2			4.01	2.29	1,960	980
LL-W-3			4.01	2.30	2,249	1,110
LL-W-4			4.01	2.29	1,590	790
LL-W-5			4.01	2.30	2,291	1,130
<b>Series Average</b>						<b>990</b>
<b>Standard Deviation</b>						138
<b>Coefficient of Variation (%)</b>						13.9

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

Specimen No.	Test Conditions	Support Span (in)	Specimen Dimensions (in)		Failure Load (lb <sub>r</sub> )	Flexural Strength (psi)
			Width	Depth		
LL-D-1	Parallel to stone rift orientation  Dry Condition	7.0	4.02	2.30	1,526	750
LL-D-2			4.01	2.30	2,572	1,270
LL-D-3			4.01	2.30	2,709	1,340
LL-D-4			4.01	2.30	1,743	860
LL-D-5			4.01	2.30	2,436	1,210
<b>Series Average</b>						<b>1,090</b>
<b>Standard Deviation</b>						263
<b>Coefficient of Variation (%)</b>						24.1

**Conclusion:**

The test results were evaluated against the performance criteria presented in ASTM C1527, Table 1 and ANSI A326.3. The results of these evaluations are presented in the tables below:

<b>ASTM C1527 Performance Evaluation Summary</b>				
<b>Physical Requirement</b>	<b>Test Series Detail</b>		<b>Result</b>	
			<b>Mean Test Value</b>	<b>Class I (Exterior) Performance Evaluation</b>
<b>C97 Absorption (%):</b> Class I (Exterior), Class II (Interior): $\geq 2.5$			0.79%	Meets as Stated
<b>C97 Density (lbs/ft<sup>3</sup>):</b> Class I (Exterior), Class II (Interior): $\geq 144$			156.1 lbs/ft <sup>3</sup>	Meets as Stated
<b>C170 Compressive Strength (psi):</b> Class I (Exterior): $\geq 7,500$ Class II (Interior): $\geq 5,000$	Perpendicular	Wet	13,840	Meets as Stated
		Dry	11,920	
	Parallel	Wet	11,980	
		Dry	12,280	
<b>C1353 Abrasion Resistance:</b> Class I (Exterior), Class II (Interior): $H_a \geq 10$			10.1	Meets as Stated
<b>C880 Flexural Strength (psi):</b> Class I (Exterior), Class II (Interior): $\geq 500$	Perpendicular	Wet	940	Meets as Stated
		Dry	1,150	
	Parallel	Wet	710	
		Dry	580	
<b>C99 Modulus of Rupture (psi):</b> No Performance Criteria Stated	Perpendicular	Wet	1,470	Design Property Only
		Dry	1,490	
	Parallel	Wet	990	
		Dry	1,090	

<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): DCoF <math>\geq</math>0.42</b>		0.77	Meets as Stated

#### **ASTM C1527 – Travertine Properties Evaluation**

The Continental Buff Travertine product satisfied the ASTM C1527 performance requirements for a Class I (Exterior) Travertine product for Absorption, Density, Compressive Strength, Flexural Strength, and Abrasion Resistance.

There are no ASTM C1527 performance criteria for ASTM C99 modulus of rupture, so these values are reported as a design property only.

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

The Continental Buff Travertine product (Honed Finish) satisfied the ANSI A326.3 recommended minimum wet condition performance criteria of 0.42 DCoF.

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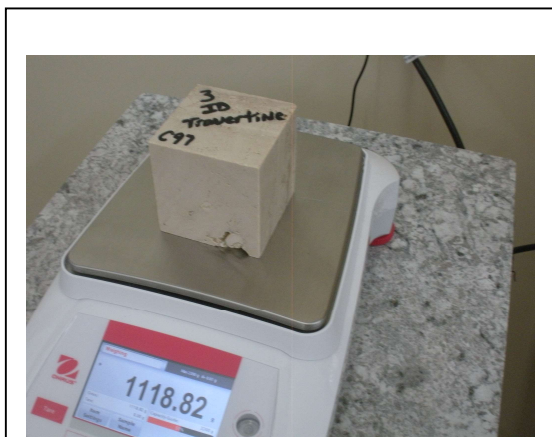
Email: [scott@naturalstoneinstitute.org](mailto:scott@naturalstoneinstitute.org)

#### Revision Log

No.	Date	Page(s)	Description
0	12/12/22	N/A	Initial report release
1	01/19/23	1, 2, 4 4 11	Added references to associated petrographic analysis. Editorial change to C135 data table C99 results updated in performance evaluation summary

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

**Photographs**



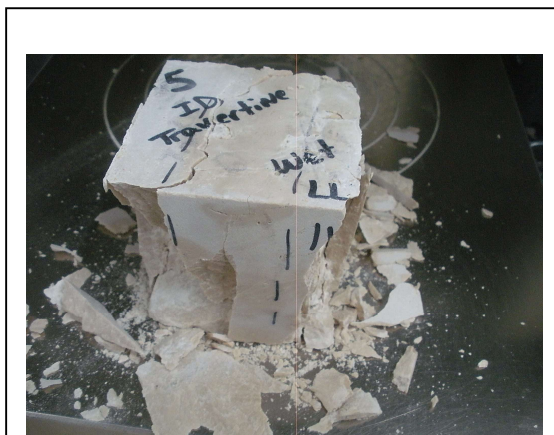
**Photo No. 1**  
ASTM C97 – Test Apparatus



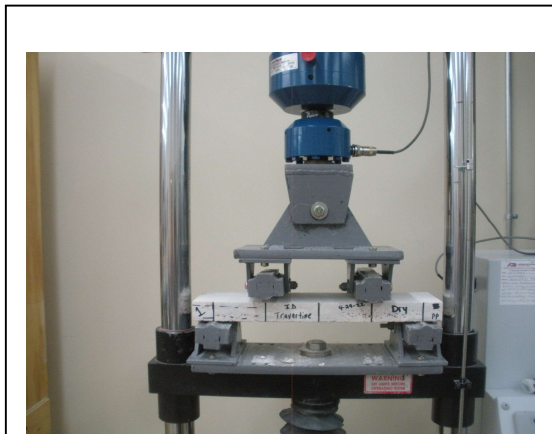
**Photo No. 2**  
ASTM C97 – Suspended Mass  
Determination Depicted



**Photo No. 3**  
ASTM C170 – Pretest Condition Specimen



**Photo No. 4**  
ASTM C170 – Representative Specimen  
Failure Mode



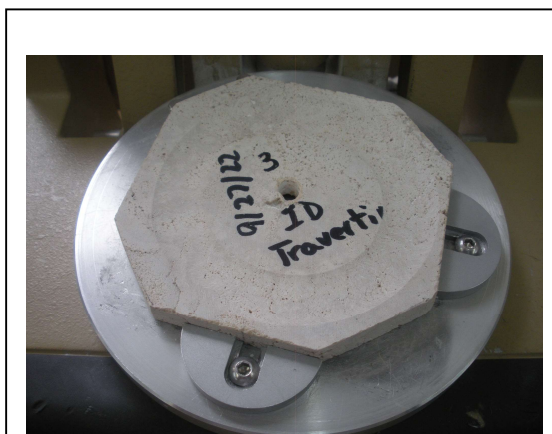
**Photo No. 5**  
ASTM C880 – Test Setup



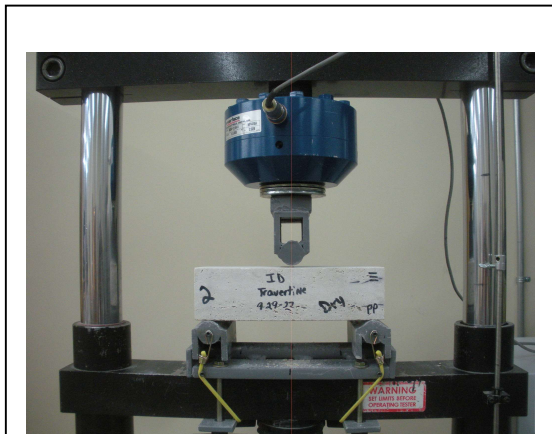
**Photo No. 6**  
ASTM C880 – Representative Specimen Failure Mode



**Photo No. 7**  
ASTM C1353 – Test Apparatus (Depicted with Pre-Abrasion Test Specimen)



**Photo No. 8**  
ASTM C1353 – Representative Post-Abrasion Specimen Condition



**Photo No. 9**  
ASTM C99 – Test Setup



**Photo No. 10**  
ASTM C99 – Representative Specimen Failure Mode



**Photo No. 11**  
ANSI A326.3 – Test Setup



**Photo No. 12**  
ANSI A326.3 – Test in Progress