CERTIFIED TEST REPORT

PHYSICAL REQUIREMENTS OF ARCHITECTURAL CAST STONE
- Per ASTM C1364 -

Report Number: R-5.10_07-28-20_PS
Date: October 13, 2020

REPORT PREPARED FOR:

piazza STONEWORKS

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Quality System: The Structures and Materials Laboratory (SML) maintains a quality system in compliance with ISO 17025-2017, accredited under International Accreditation Service (IAS), testing laboratory TL-478 and qualified laboratory by the Florida Department of Transportation (FDOT) number ISM028. All the test results presented herein are linked through unbroken chain data. Analyzed data is obtained directly from the recorded raw data during testing, from which the test results are presented. This report contains analyzed tabulated data results.

Procedures: All tests and services are done in accordance with the SML Quality Manual (Version 6.0) revised November 30, 2019; relevant standard operating procedures (SOPs); and with the applicable requirements of the reference standard test methods, unless otherwise stated.

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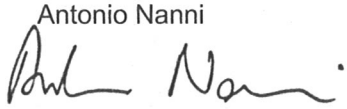
Controls:	
Superseded Report	New report
Reason for Revision	n/a
Effective Date	October 13, 2020

Test Report Approval Signatures:	
Quality review Approval	I indicate that I have reviewed this Test Report and agree with the contents it presents, and find it meets all applicable laboratory requirements and policies. I approve for its release to the customer. Name: Francisco De Caso Signature:  Date: October 13, 2020
Technical review Approval	I indicate that I have reviewed this Test Report and agree with the technical contents it presents, and find it meets all applicable laboratory requirements and policies. I approve for its release to the customer. Name: Antonio Nanni Signature:  Date: October 13, 2020

1. COMPRESSIVE STRENGTH - ASTM C1194

1.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of the compressive strength of cubes
Sample Under Evaluation:	Cubes extracted from a Piazza Stonework cast block.
Test Standard Method/s:	ASTM C1194-19, Standard Test Method for Compressive Strength of Architectural Cast Stone. ASTM C1364-19, Standard Specification for Architectural Cast Stone. C109/C109M-16a Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
Test Set-up:	Load was applied with a universal test frame through a spherical bearing block placed on top of the centered specimen parallel to the casting direction. Load rate of 250 psi/s was applied. The maximum load at failure was recorded. Refer to Figure 1.1.
Test Location:	Structures and Materials Laboratory at the University of Miami. 1251 Memorial Dr., MEB108 Coral Gables, FL, 33146.
Analyst/s:	Juan Manuel Palacios.
Technical Test Record:	TDS_ASTMC1194_PS-4.
Specimen Dimensions:	2 in. ± 1/8 in. cubes.
Specimen Preparation:	Five test cubes were cut from a cast block using a high precision circular saw.
Sampling Reference:	Provided by the client.
Specimen Conditioning:	The cubes were oven dried at a temperature of 230 ± 9°F (110 ± 5°C) until the loss in mass in 24h was less than 0.1%. Specimens were then removed from the oven to cool down for 6 h.
Specimen ID:	Specimens are labeled and uniquely identified for quality and traceability using the format M_X; where M is the tested property (C for compressive strength); and X is specimen repetition number (1 to 5). Refer to Table 1.1.
Test Results:	ASTM C1364 requirement is met, where the compressive strength shall be more than 6500 psi. Refer to Table 1.2 and Figure 1.1.

Table 1.1 – Test matrix for ASTM C1194

Specimen ID	Material Identification	Specimen Preparation (mm.dd.yy)	Test date (mm.dd.yy)
C_01 to 05	Piazza StoneWorks Mix	08.25.20	10.07.20

1.2. TEST RESULTS

Table 1.2 – Compressive strength test results, per ASTM C1194

Specimen ID	Area A		Maximum Load P_{max}		Compressive strength f_{cm}	
	mm²	in²	kN	lbf	MPa	psi
C_01	2578	4.00	126.22	28375	48.97	7102
C_02	2625	4.07	121.55	27326	46.31	6717
C_03	2672	4.14	127.45	28652	47.69	6917
C_04	2632	4.08	125.85	28293	47.81	6934
C_05	2673	4.14	121.33	27277	45.39	6583
Average	**2636**	**4.09**	**124.48**	**27985**	**47.23**	**6851**
Sn-1	40	0.06	2.84	638	1.40	203
CV((%)	1.5	1.5	2.3	2.3	3.0	3.0

**Refer to Figure 1.1 for representative failure mode.*

1.3. VISUAL DOCUMENTATION

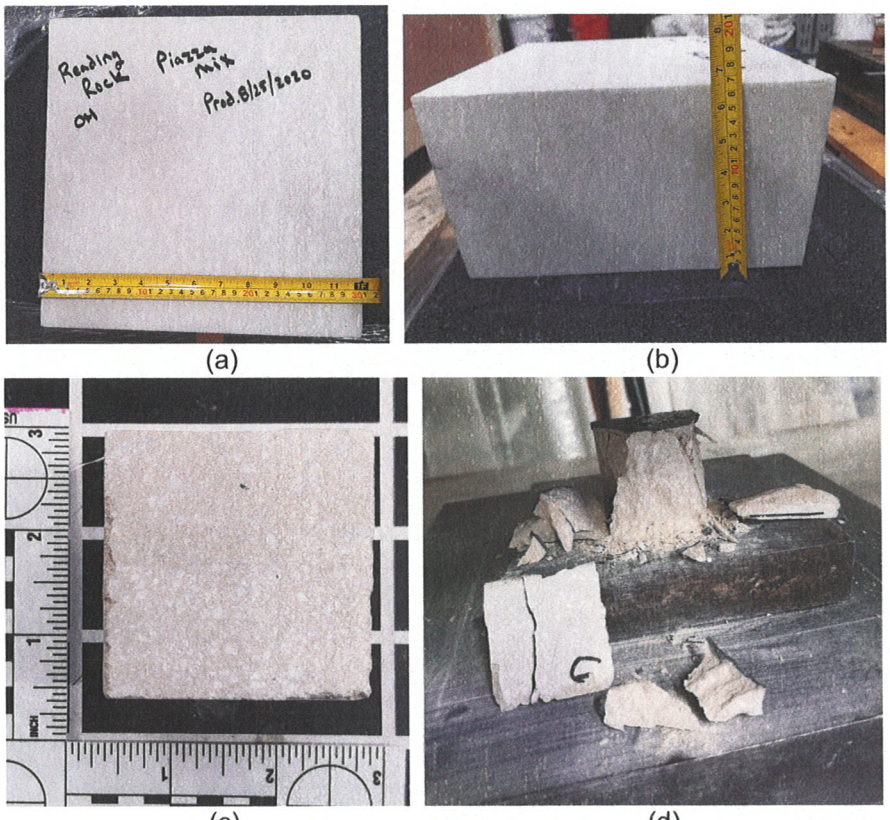


Figure 1.1 – (a) Cast block specimen plan view; (b) Cast block specimen elevation view; (c) Cube specimen prior testing; and (d) representative cone type failure mode of cube specimen

2. ABSORPTION - ASTM C1195

2.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of the absorption value of cast cubes made from dry bagged mortar mixture.
Sample Under Evaluation:	Piazza Stonework bagged mortar mix.
Test Standard Method/s:	ASTM C1195–19a, Standard Test Method for Absorption of Architectural Cast Stone. ASTM C1364-19, Standard Specification for Architectural Cast Stone.
Test Set-up:	Specimens were cured and conditioned as specified herein and the mass of dried specimens was recorded. Then, specimens were immersed in water at a temperature of 23.0 ± 1.0°C (73.4 ± 1.8°F) for 48 ± 1 h. At the end of this period, the mass of the specimens was recorded after the surface water was removed with a damp cloth. Refer to Figure 2.1.
Test Location:	Structures and Materials Laboratory at the University of Miami. 1251 Memorial Dr., MEB108 Coral Gables, FL, 33146.
Analyst/s:	Juan Manuel Palacios and Morteza Khatib.
Technical Test Record:	TDS_ASTMC1195_PS-1.
Specimen Dimensions:	2 in. ± 1/8 in. cubes.
Specimen Preparation:	Three test cubes were cast using bagged mortar mixtures per ASTM C192 - 19 (Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory). Specimens were demolded after 24 h.
Sampling Reference:	Provided by the client.
Specimen Conditioning:	Test cubes were moist cured at a temperature of 23.0 ± 1.0°C (73.4 ± 1.8°F) and 100 ± 2% relative humidity for a period of 28 days. Then the cubes were oven dried at a temperature of 230 ± 9°F (110 ± 5°C) until the mass loss was not more than 0.1% in 24 hr. Specimens were then removed from the oven and allowed to cool down for 6 h.
Specimen ID:	Specimens are uniquely identified for quality and traceability using the format M_X; where M is the tested property (A for water absorption); and X is repetition number (1 to 3). Refer to Table 2.1.
Test Results:	ASTM C1364 requirement is met, where absorption must be less than 6%. Refer to Table 2.2.

Table 2.1 – Test matrix for ASTM C1195

Specimen ID	Material Identification	Specimen Preparation (mm.dd.yy)	Test date (mm.dd.yy)
A_01 to 03	Piazza Stonework bagged mortar mix	03.09.20	04.14.20

2.2. TEST RESULTS

Table 2.2 – Absorption test results, per ASTM C1195

Specimen ID	Mass of Dried Specimen (A)		Mass of Specimen After Immersion (B)		Absorption
	grams	*lbs*	*grams*	*lbs*	*Mass %*
A_01	259.3	0.57	265.5	0.59	2.4
A_02	252.7	0.56	259.7	0.57	2.8
A_03	256.2	0.56	263.4	0.58	2.8
Average					**2.7**
S_{n-1}					0.2
CV((%)					8.6

2.3. VISUAL DOCUMENTATION

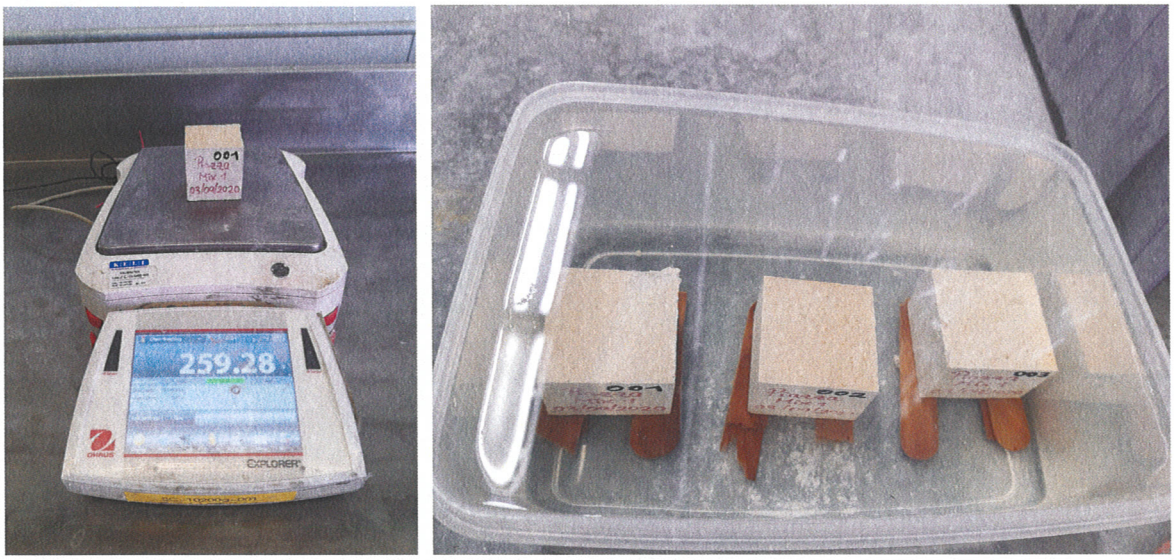


Figure 2.1 – Absorption test setup

3. LINEAR DRYING SHRINKAGE - ASTM C426

3.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of the linear drying shrinkage of cast prisms made from dry bagged mortar mixture.
Sample Under Evaluation:	Piazza Stonework bagged mortar mixed.
Test Standard Method/s:	ASTM C426 – 16, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units. Modified for prim type specimen. ASTM C490 – 17, Standard Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete. ASTM C157 – 17, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete. ASTM C1364-19, Standard Specification for Architectural Cast Stone.
Test Set-up:	Specimens were immersed in water at 73.4 ± 2°F [23 ± 1.1°C] for 48 ± 2 h. The initial reading was recorded using the comparator fixture. Specimens were stored in air at 75 ± 15°F [24 ± 8°C] and a relative humidity of less than 80 % for 48 h. Then, the specimens were dried in the oven with a constant uniform temperature of 122 ± 2°F [50 ± 0.9°C] and relative humidity of 17 ± 2% for 3 days. The readings were taken using comparator after cooling the specimen to the room temperature at 73 ± 1°F for 8 hours. Specimens were returned to the oven for another 44±4 h followed by cooling and length measurement cycles for the period of time as reported in the results. Refer to Figure 3.1.
Test Location:	Structures and Materials Laboratory at the University of Miami. 1251 Memorial Dr., MEB108 Coral Gables, FL, 33146.
Analyst/s:	Juan Manuel Palacios.
Technical Test Record:	TDS_ASTMC426_PS-3.
Specimen Dimensions:	3.0 x 3.0 x 11.0 in. prisms (width x depth x length)
Specimen Preparation:	Three test prisms were cast using bagged mortar mixtures per ASTM C192 - 19 (Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory). Specimens were demolded after 24 h, and immersed in lime water for 48 hours at 23.0 ± 1.1°C (73.4 ±2°F).
Sampling Reference:	Provided by the client.
Specimen Conditioning:	Oven dry 50 ±0.9°C (122 ±2°F) for 44±4h followed for 8h at cooling 23.0 ± 1.1°C (73.4 ±2°F).

Specimen ID: Specimens are labeled and uniquely identified for quality and traceability using the format M_X; where M is the tested property (LDS - Linear Drying Shrinkage); and X is specimen repetition number (1 to 3). Refer to Table 3.1.

Test Results: ASTM C1364 has no specific requirement for this physical property. Refer to Table 3.2 and Table 3.3. Note since the temperature of the room during cooling period and length measurement was at 73 ± 1°F, no correction was needed to be applied to readings.

Measurement period ends meeting with test condition which include:

i) Average length change of the test specimens is 0.002 %, or less, over a span of 6 days of drying, and/or

ii) Average weight loss in 48 h of drying is 0.2 % or less compared to the last previously determined weight.

Table 3.1 – Test matrix, per ASTM C429

Specimen ID	Material Identification	Specimen Preparation (mm.dd.yy)	Start of Shrinkage Test (mm.dd.yy)	End of Shrinkage Test (mm.dd.yy)
LDS_01 to 03	Piazza Stonework bagged mortar mix	07.28.20	07.31.20	09.16.20

3.2. TEST RESULTS

Table 3.2 – Linear shrinkage results, reported as percent decrease in the specimen length, per ASTM C426

Specimen ID	Drying Period (days)								
	5	**7**	**10**	**12**	**14**	**17**	**19**	**21**	**24**
LDS_01	-0.052	-0.061	-0.084	-0.096	-0.100	-0.111	-0.116	-0.118	-0.125
LDS_02	-0.094	-0.111	-0.125	-0.135	-0.140	-0.149	-0.154	-0.158	-0.163
LDS_03	-0.053	-0.071	-0.086	-0.100	-0.106	-0.116	-0.120	-0.124	-0.130
Average	**-0.066**	**-0.081**	**-0.098**	**-0.110**	**-0.115**	**-0.125**	**-0.130**	**-0.133**	**-0.139**
S_{n-1}	0.019	0.021	0.019	0.018	0.017	0.017	0.017	0.018	0.017
CV((%)	-29.0	-26.4	-19.2	-16.1	-15.2	-13.4	-13.1	-13.3	-12.3

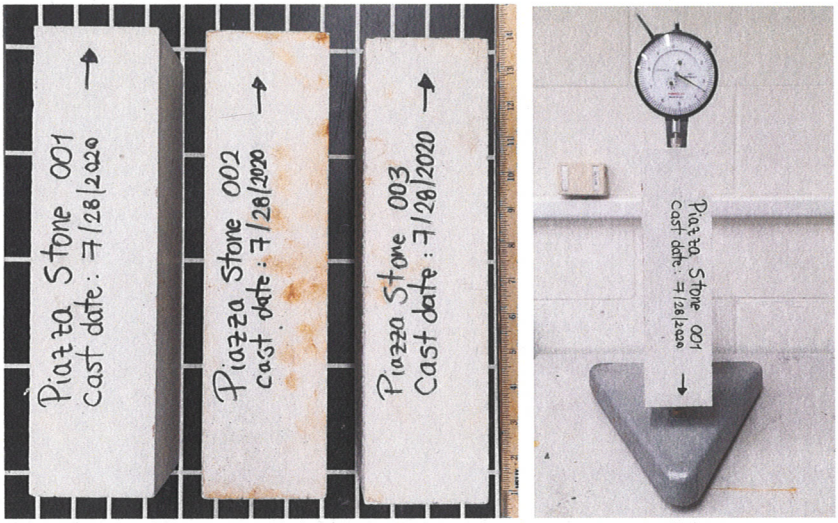
Specimen ID	Drying Period (days)								
	26	**28**	**31**	**33**	**35**	**39**	**41**	**45**	**47**
LDS_01	-0.127	-0.128	-0.132	-0.137	-0.133	-0.137	-0.139	-0.139	-0.137
LDS_02	-0.164	-0.166	-0.170	-0.175	-0.172	-0.177	-0.178	-0.176	-0.175
LDS_03	-0.130	-0.132	-0.137	-0.140	-0.135	-0.141	-0.143	-0.143	-0.142
Average	**-0.140**	**-0.142**	**-0.146**	**-0.151**	**-0.147**	**-0.152**	**-0.153**	**-0.152**	**-0.151**
S_{n-1}	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.017	0.017
CV((%)	-11.8	-12.0	-11.6	-11.4	-12.1	-12.0	-11.5	-10.9	-11.2

Table 3.3 – Weight loss of test specimens (%) per ASTM C426

Specimen ID	Drying Period (days)								
	5	**7**	**10**	**12**	**14**	**17**	**19**	**21**	**24**
LDS_01	-2.330	-2.963	-3.608	-3.913	-4.172	-4.510	-4.700	-4.862	-5.078
LDS_02	-2.337	-2.930	-3.578	-3.893	-4.153	-4.489	-4.688	-4.850	-5.065
LDS_03	-2.270	-2.936	-3.558	-3.848	-4.106	-4.443	-4.631	-4.787	-4.999
Average	**-2.312**	**-2.943**	**-3.582**	**-3.885**	**-4.144**	**-4.481**	**-4.673**	**-4.833**	**-5.047**
S_{n-1}	0.030	0.014	0.021	0.027	0.028	0.028	0.030	0.033	0.035
CV((%)	-1.3	-0.5	-0.6	-0.7	-0.7	-0.6	-0.6	-0.7	-0.7

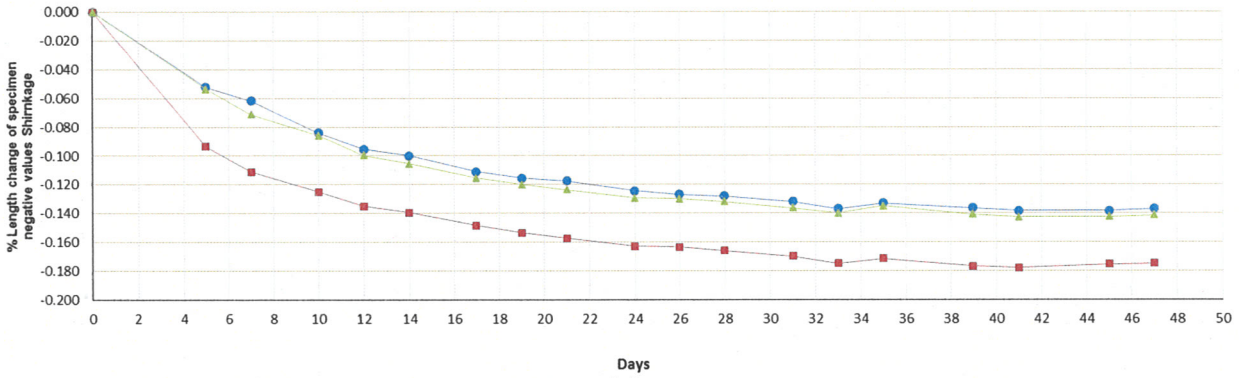
Specimen ID	Drying Period (days)								
	26	**28**	**31**	**33**	**35**	**39**	**41**	**45**	**47**
LDS_01	-5.136	-5.247	-5.430	-5.524	-5.623	-5.778	-5.855	-5.953	-6.024
LDS_02	-5.136	-5.262	-5.443	-5.531	-5.632	-5.788	-5.863	-5.891	-6.037
LDS_03	-5.074	-5.207	-5.388	-5.483	-5.582	-5.740	-5.816	-5.919	-5.993
Average	**-5.115**	**-5.238**	**-5.420**	**-5.513**	**-5.612**	**-5.768**	**-5.845**	**-5.921**	**-6.018**
S_{n-1}	0.029	0.023	0.023	0.021	0.021	0.021	0.021	0.026	0.018
CV((%)	-0.6	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3

3.3. VISUAL DOCUMENTATION

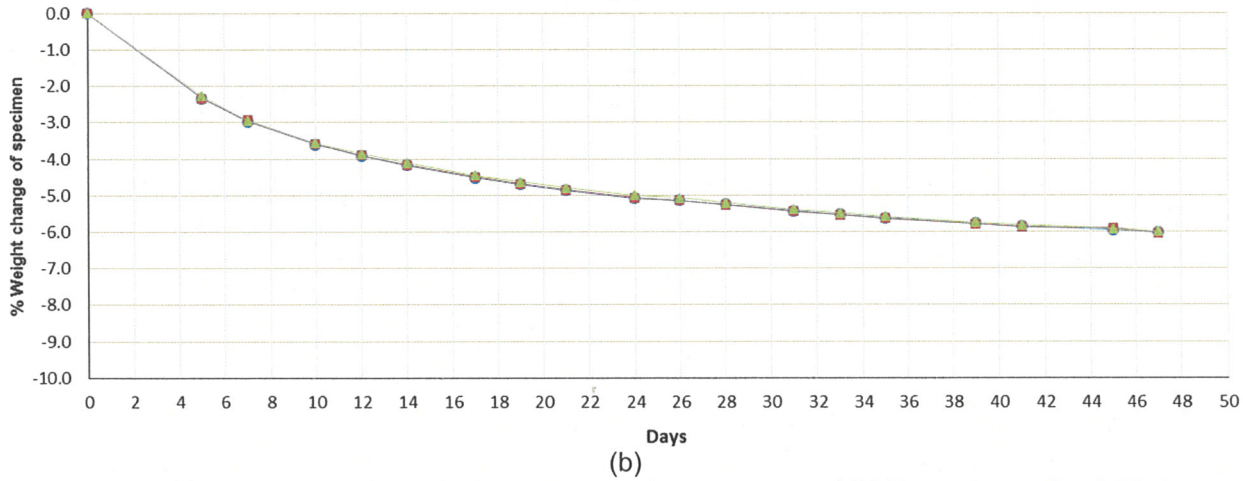


(a) (b)

Figure 3.1 – (a) Test specimens during cooling cycle, and (b) Comparator fixture test set up



(a)



(b)

Figure 3.2 – (a) Percentage of length change versus time repose; and (b) Percentage of weight change versus time response of specimens

4. AIR CONTENT - ASTM C231

4.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of the air content of freshly mixed mortar mixture.
Sample Under Evaluation:	Piazza Stonework bagged mortar mixed 07/28/20.
Test Standard Method/s:	ASTM C231/C231M-17a, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method. ASTM C1364-19, Standard Specification for Architectural Cast Stone.
Test Set-up:	An air meter with a pressure dial gauge (Type B) was used. The mortar was placed in the measuring bowl in three layers of approximately equal volume. After every layer the mix was rod and tapped. After completion of consolidation, the measuring bowl not contained an excess or deficiency of concrete and cover was placed and sealed. Refer to Figure 4.1.
Test Location:	Structures and Materials Laboratory at the University of Miami. 1251 Memorial Dr., MEB108 Coral Gables, FL, 33146.
Analyst/s:	Juan Manuel Palacios.
Technical Test Record:	TDS_ASTMC231_PS-3.
Specimen Preparation:	Bagged mortar mix, fresh mix.
Sampling Reference:	Provided by the client.
Specimen Conditioning:	23 ± 1°C (73 ± 3°F) and 60 ± 5% RH.
Specimen ID:	Specimens are uniquely identified for quality and traceability using the format M_X; where M is the tested property (AC for Air Content); and X is specimen repetition number (1 to 3). Refer to Table 4.1.
Test Results:	The average air content of a freshly mixed (full) bag was 9.5%.

Table 4.1 – Test matrix for ASTM C231

Specimen ID	Material Identification	Specimen Preparation (mm.dd.yy)	Test date (mm.dd.yy)
AC_01 to 03	Piazza Stonework bagged mortar mix	07.28.20	07.28.20

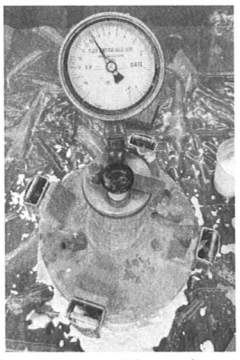


Figure 4.1 – Representative air meter test setup

5. FREEZE-THAW - ASTM C666

5.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of resistance to freezing and thawing of cast prisms made from dry bagged mortar mixture.
Sample Under Evaluation:	Piazza Stonework bagged mortar mix.
Test Standard Method/s:	ASTM C666/C666M – 15, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing. ASTM C1364 - 19, Standard Specification for Architectural Cast Stone.
Test Set-up:	Prisms specimens where placed in individual containers and exposed to 300 freezing and thawing cycles as per ASTM C666, Procedure A. The method of evaluation was based on mass loss. Refer to Figure 4.1.
Test Location:	Structures and Materials Laboratory at the University of Miami. 1251 Memorial Dr., MEB108 Coral Gables, FL, 33146.
Analyst/s:	Juan Manuel Palacios and Morteza Khatib.
Technical Test Record:	TDS_ASTMC666_PS-1.
Specimen Dimensions:	3 x 4 x 16 in. prisms (width x depth x length)
Specimen Preparation:	Three test prisms were cast using bagged mortar mixtures per ASTM C192 - 19 (Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory). Specimens were demolded after 24 h.
Sampling Reference:	Provided by the client.
Specimen Conditioning:	Test prisms were moist cured at a temperature of 23.0 ± 1.0°C (73.4 ± 1.8°F) and 100 ± 2% relative humidity for a period of 47 days. Then, specimens were submerged in lime-saturated water at 23 ± 1.7°C (73.4 ± 3°F) for 48 hours.
Specimen ID:	Specimens are labeled and uniquely identified for quality and traceability using the format M_X; where M is the tested property (FT for Freeze-Thaw); and X is specimen repetition number (1 to 3). Refer to Table 5.1.
Test Results:	ASTM C1364 requirement is met for air content (as reported in Section 4) and resistance to freezing and thawing, as CPWL is less than 5%. Refer to Table 5.2 and Table 5.3. The mass of the specimens was recorded every 45 cycles. At the end of 315 cycles, the spalled materials was collected, dried and weighed. The beams were also oven dried and their mass recorded. The cumulative percent loss for each beam was calculated per ASTM C1364.

Table 5.1 – Test matrix for ASTM C666

Specimen ID	Material Identification	Specimen Preparation *(mm.dd.yy)*	Start of Test *(mm.dd.yy)*
FT_01 to 03	Piazza Stonework bagged mortar mix	03.09.20	04.27.20

5.2. TEST RESULTS

Table 5.2 – Mass change as percentage test results, per ASTM C666

Specimen ID	Freezing and Thawing Cycles						
	45	***90***	***135***	***180***	***225***	***270***	***315***
FT_01	0.13	0.30	0.27	0.37	0.39	0.45	0.49
FT_02	0.15	0.32	0.26	0.37	0.42	0.56	0.62
FT_03	0.11	0.24	0.23	0.29	0.28	0.34	0.39
Average	**0.13**	**0.29**	**0.26**	**0.35**	**0.36**	**0.45**	**0.50**
S_{n-1}	0.02	0.05	0.02	0.05	0.07	0.11	0.12
CV((%)	0.15	0.16	0.08	0.13	0.19	0.24	0.24

Table 5.3 – Cumulative percent pass loss

Specimen ID	Initial Beam Mass *A*	Oven Dried Beam Mass at the End of the Test *B*	Total Dry Mass of Spalled Material *S*	Cumulative Percent Mass Loss *CPWL**
FT_01	6789.72	6292.72	29.27	0.5
FT_02	7297.43	6810.24	40.21	0.6
FT_03	7112.98	6603.38	34.05	0.5
Average				**0.5**
S_{n-1}				0.001
CV((%)				12

*Air-content per ASTM C1364 is sufficient as freeze-thaw requirements is met.

5.3. VISUAL DOCUMENTATION

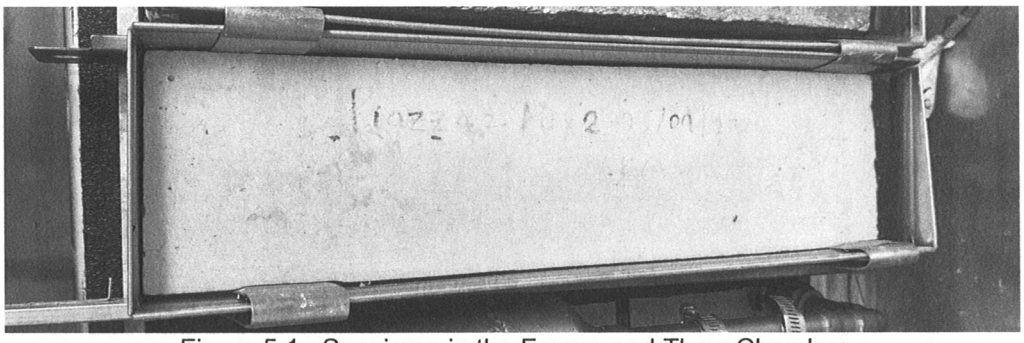


Figure 5.1 –Specimen in the Freeze and Thaw Chamber

♦ **END OF TEST REPORT** ♦