

RADCO TEST REPORT

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Tests per ICC ES Acceptance Criteria for Precast Stone Veneer (AC51)

Prepared for

Native Custom Stone, LLC 236 Hightower Parkway Dawsonville, GA. 30534

by

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1.0 INTRODUCTION

At the request of Native Custom Stone, Inc., the tests listed in Section 3.0 below were conducted on their stone veneer products in accordance with the ICC ES "*Acceptance Criteria for Precast Stone Veneer*", (AC51) Approved February 2008, Effective March 1, 2008.

2.0 MATERIAL DESCRIPTION

All products for testing were selected by Quality Control Consultants (QCC), Roswell, GA (IAS AA-727) from the Native Custom Stone plant in Dawsonville, GA on 3/17/2011. QCC also witnessed the molding of the test specimens. The molds for all small scale specimens were provided to Native Custom Stone by RADCO. The molded specimens were shipped overnight to RADCO's testing facility in Long Beach, California. The QCC sample selection letter is attached.

3.0 TEST PROGRAM

The following tests were conducted per ICC ES AC51.

TEST

- 1. Density
- 2. Dimensions and Tolerances
- 3. Compressive Strength on 6" x 12" cylinders
- 4. Tensile Strength
- 5. Flexural Strength
- 6. Water-absorption
- 7. Compressive Strength on 2"x2" mortar cubes
- 8. Freeze-thaw
- 9. Shear Bond Strength

REFERENCED STANDARD ASTM D567-81(1996) AC51-2008 ASTM C39-1999 ASTM C190-1985 ASTM C348-1986 ASTM C567-1981(1996) ASTM C109-2005 ASTM C67-2003 ASTM C482-2002

4.0 TEST PROCEDURES AND RESULTS

Unless otherwise noted all test specimens were conditioned for 48 hours at standard laboratory conditions 73 $^{\circ}$ F (22.8 $^{\circ}$ C) and 50% RH before testing.



4.1 Density & Weight per ASTM C567-1981 (Reapproved 1996)

Five (5) veneer samples were tested. The sample weights were taken while suspended and after being completely submerged in water at 73.5 ± 3 °F for 24 hours. The samples were removed from the water and allowed to drain for 1 min and visible water was removed with a damp cloth, and the weight was taken again. The samples were then air-dried by conditioning them at 50 ± 5 % relative humidity and 73.5 ± 3 °F until the mass of the specimen changed no more than 0.5 % in successive determinations of mass 28 days apart.

 E_{m} (Density, kg/m³) = (A x 997) / (B - C) E_{m} (Density, lb/ft³) = (A x 62.3) / (B - C)

 $E_m = equilibrium density$

A = 28 day weight

B = saturated, surface dry weight

C = suspended - immersed weight

Sample	Dry Saturated	Suspended	Density		
	A A	B B	C C	kg/m³	lb/ft ³
1	465.21	496.33	191.80	1523.05	95.17
2	319.08	340.81	134.94	1545.26	96.56
3	632.22	667.91	252.14	1516.04	94.73
4	319.90	341.86	133.77	1532.70	95.77
5	481.46	509.56	193.33	1517.93	94.85
Average				1527.00	95.42
Standard Deviation				12.08	0.76

Condition of Acceptance

The saturated weight of the veneer units cannot exceed 15 pounds per square foot (73 kg/m²) per AC51, section 3.1.2.

Analysis

Max. Thickness (ft) = 15 lb/ft² / Density (lb/ft³) 15/95.42 = 0.157 ft = 1.9 in

Conclusion: The maximum thickness of the samples tested was less than 1.9 in. The specimens tested comply with the density requirements of AC51, section 3.1.1.



Verification Procedure

- 1. RADCO verified through physical measurements of all products submitted and selected the thickest products for this evaluation.
- 2. Pieces of the veneer were selected such that the total surface area was equal to one square foot. Two such one sq. ft. sets were evaluated.
- 3. The volume of these pieces was determined using a water displacement method.

Volume of 1 sq. ft.	=	2,946.6 cc = 0.10406 cubic ft. [Eighteen (18) pieces measured]
Density of material	=	95.42 lb/ft ³ (from section 4.1 of this report)
Water Absorption	=	14.38% (from section 4.6 of this report)

Per section 4.1(3) of AC51, the equilibrium density shall be increased by the percentage of water absorption and multiplied by the volume of veneer per unit area of wall to determine the average saturated weight.

95.42 x 14.38% = 109.14 lbs./ft³ 109.14 lbs./ft³ x 0.10406 ft³ = **11.36 lbs./ft² (55.46 kg/m²)**

Conclusion:

The average saturated weight of the Native Stone product is 11.36 lbs./ft².

This meets the requirement of section 3.1.2 of AC51 which states that the average saturated weight must not exceed 15 pounds per square foot (73 kg/m²).

4.2 Dimensions and Tolerances per AC51-2008

The greatest dimension of the samples submitted were as follows:

4x13 inches and 52 square inches in total area. The minimum and maximum thickness of the veneer submitted was 3/4 and 1.85 inches respectively.

<u>Conclusion</u>: The dimensions comply with the IBC and IRC dimensional requirements of AC51, section 2.1.1.2.



4.3 Compressive Strength of Veneer Mixture per ASTM C39-99ae1

Five (5) 6" x 12" cylinders of the veneer mix were prepared by Native Custom Stone personnel and witnessed and documented by QCC. The tests specimens were allowed to moist cure for 28 days at 73.5 ± 3.5 °F. The test was conducted by Southwest Inspection & Testing, Inc., La Habra, CA (IAS TL-160) under RADCO's direction.

Sample	Maximum Load (lbf)	Compressive Strength (psi)	Type of Fracture
1	154,932	5,480	П
2	160,563	5,680	Ш
3	163,212	5,770	Ш
4	159,690	5,650	Ш
5	164,407	5,820	I
Average	160,561	5,680	
Standard Deviation	3,683	131	

<u>Condition of Acceptance</u>: Minimum requirements are 1,800 psi (12.4 MPa) average for five specimens, and 1620 psi for individual specimens.

Conclusion: The test results comply with the requirements of AC51, Section 3.1.3.1

4.4 Tensile Strength per ASTM C190-1985

Five (5) dog bone shape specimens of the veneer mixture were prepared by Native Custom Stone personnel and witnessed and documented by QCC. After approximately 24 hour curing, the samples were immersed in saturated lime water until they were tested. A tensile load was applied at the rate of 600 ± 25 lbf (2.67 ± 0.11 kN) per minute until failure occurred. The test was conducted on a United Table Model Electromechanical Universal Testing Machine (model number TM-20) equipped with an electronic load cell and a computerized data acquisition system. The tensile strength at 28 days is shown in the table below.

RADC

Sample	Tensile Strength (psi)
1	239,299
2	250,521
3	251,266
4	227,366
5	241,941
Average	242,079
Standard Deviation	9,745

<u>Conclusion:</u> The results of any sample do not vary by more than 10 percent from the average of all samples. The test results comply with the requirements of AC51, Section 3.1.3.2.

4.5 Flexural Strength per ASTM C348-1986

Five (5) specimens of the veneer mixture were prepared by Native Custom Stone personnel and witnessed and documented by QCC. After approximately 24 hour curing, the samples were immersed in saturated lime water until they were tested. A load was applied at the rate of 600 ± 25 lbf (2640 \pm 110 N) per minute until failure occurred. The test was conducted on a United Table Model Electromechanical Universal Testing Machine (model number TM-20) equipped with an electronic load cell and a computerized data acquisition system. The flexural strength at 28 days is shown in the table below.

Sample	Maximum Load		Flexural Strength	
	lbf	N	psi	MPa
1	445.46	1981.50	804.71	5.55
2	414.94	1845.75	749.58	5.17
3	481.54	2142.01	869.90	6.00
4	451.18	2006.95	815.05	5.62
5	420.13	1868.83	758.95	5.23
Average	442.65 1969.01		799.64	5.51
Standard Deviation	tandard Deviation 26.78 119.12		48.37	0.33

<u>Conclusion:</u> The results of any sample do not vary by more than 10 percent from the average of all samples. The test results comply with the requirements of AC51, Section 3.1.3.3.



4.6 Moisture Absorption per AC51-2008

Ten (10) tile pieces taken from the samples fractured in the strength tests above were tested in accordance with AC51. All of the pieces were dried in a well-ventilated oven for 24 hours at 221 \pm 3.6 °F and then the dried samples were weighed individually after they were cooled at room temperature for 15 minutes. Then these samples were immersed in distilled water for 48 hours at 68 \pm 9 °F.

The samples were removed from the water after 48 hours, the surfaces wiped dry, and weighed immediately.

Sample No.	Dry Weight (g)	Saturated Weight (g)	Water Absorption (%)
1	172.82	198.18	14.67%
2	174.94	200.61	14.67%
3	171.63	197.49	15.07%
4	171.28	196.35	14.64%
5	170.83	195.94	14.70%
6	65.88	75.12	14.03%
7	53.34	61.04	14.44%
8	66.35	76.04	14.60%
9	928.59	1044.39	12.47%
10	1241.48	1421.76	14.52%
	Average	14.38%	
	0.72%		

The density of the material is 95.42 lb/ft³ per section 4.1 of this report. In accordance with Table 2 of AC 51, the maximum permitted water absorption percentage is 18%.

Condition of Acceptance: No sample shall absorb more than 18% water of its dry weight.

Conclusion: The test results comply with the requirements of AC51, Section 3.1.4.



4.7 Freeze-thaw per ASTM C67-03ae01

The test was conducted in accordance with ASTM C67-03 on five specimens. The specimens were exposed to 50 cycles of freezing and thawing. Each cycle consisted of twenty (20) hours ± 1 hour of freezing in a freezing chamber maintained at a setting that did not allow the temperature to exceed 16 °F one (1) hour after introducing the test specimens into the chamber, followed by four (4) hour ± 0.5 hr. of thawing by totally submerging in water at 75 °F ± 10 °F. The test was conducted from 4/11/2011 to 7/12/2011.

Initial & Final Conditioning: Drying for 24 hours at 230 to 239 °F (110 to 115 °C) and weighing until two successive weights at intervals of 2 hours show weight loss of less than 0.2% of the previously recorded weight.

Sample	Initial weight (g)	Final weight (g)	% Weight loss
1	1,034.3	1,033.3	0.09
2	1,117.9	1,116.8	0.10
3	879.7	877.6	0.25
4	872.7	871.2	0.17
5	665.5	665.2	0.03
Average	914.0	912.8	0.13
Standard Deviation	173.7	173.5	0.08

After the 50 cycles were completed, the tiles were visually inspected for any breakage or cracking, and the final dry weight was compared with the initial dry weight. The results are as follows:

<u>Condition of Acceptance</u>: There shall be no greater than 3 percent loss in dry weight of any individual specimen. The samples must not break or disintegrate.

<u>Conclusion</u>: The average weight loss for the specimens was less than the 3% maximum and complied with the requirements. No cracks or any breakage was observed in any of the five (5) samples tested. The veneers tested comply with the freeze thaw test requirements of AC51.



4.8 Compressive Strength of Mortar mixture per ASTM C109-2005

Compressive strength tests were conducted on 2 inch (51mm) cube specimens in accordance with ASTM C109-05, "*Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens*)." The cubes were made at the same time as the specimens for the shear bond strength tests using the same mortar mixture. After 24 hour moist curing the test samples were kept immersed in saturated lime water until they were tested.

Five (5) specimens were tested in compression on a United Table Model Electromechanical Universal Testing Machine (model number TM-20) equipped with an electronic load cell and a computerized data acquisition system. The compressive strength at seven (7) days is shown in the table below.

Sample	Compressive Strength (psi)		
	psi	MPa	
1	1,648.74	11.37	
2	1,678.27	11.57	
3	1,851.61	12.77	
4	1,809.60	12.48	
5	1,682.06	11.60	
Average	1,734.06	11.96	
Standard Deviation	80.77	0.56	

<u>Condition of Acceptance</u>: Section 4.7.3 of the Acceptance Criteria for Precast Stone Veneer (AC51) requires that the compressive strength for the mortar used in the shear bond test specimens not exceed the minimum specified compressive strength by more that 10 percent. The specified minimum compressive strength for Type S mortar is 1,800 psi (see IBC Table 1203.8(2)), therefore the compressive strength of the mortar at the time of shear bond testing should not be greater than 1,980 psi (1,800 + 10%).

Conclusion: The test results comply with the requirements of AC51.



4.9 Shear Bond Strength per ASTM C482-2002

All test specimens were fabricated by QCC personnel at RADCO's Long Beach, CA test facility. The fabrication was witnessed and documented by RADCO. The test specimen construction was as follows:

Types of Substrates:

- 1. Concrete masonry blocks (CMU)
- 2. Metal lath over felt paper on 7/16" OSB sheathing
- 7/16" Exposure 1 OSB attached to 12"x36" wooden frames with studs spaced at 16 inches on center.
- One layer of No.15 (ASTM D226) paper and one layer of Grade D housewrap.
- 2.5 lb self furring metal lath (ASTM C847) fastener with 1-1/2" roofing nails
- Pre-blended dry Type "S" mortar, ASTM C270, mixed with 17-19% water by weight.

<u>Mortar Application</u>: The setting bed was a minimum 3/8 inch thick and ranged from approximately 3/8 to 1/2 inch. The veneers were cut to 4"x4" and the back of the veneer was coated with a thin layer of Type S mortar before applying it to the mortared surface.

The samples were allowed to cure at 73 °F for seven (7) days prior to testing. The samples wrapped in impervious plastic film and were kept moist during the entire curing period.

Test Procedure

Five (5) samples in each type were tested in accordance with AC51, Section 4.7 by clamping to the base of a United Table Model Electromechanical Universal Testing Machine (model number TM-20) equipped with an electronic load cell and a computerized data acquisition system.

The shear load was applied through the 3/8" thick metal plate centered to the veneer sample. The load was applied at a rate of 200 ± 20 psi per minute.

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Metal Lath over Paper and OSB (Bonded area = 4"x4")				
Sample	Failure Load, lbf	Shear strength, psi		
1	2,258.99	141.19		
2	111.60			
3	1,715.09	107.19		
4	1,896.13	118.51		
5	1,777.65	111.10		
Average	1,886.69	117.92		
Standard Deviation	218.09	13.63		

CMU Blocks (Bonded area = 4"x4")					
Sample Failure Load, lbf Shear strength, ps					
1	1,744.17	109.01			
2	1,987.23	124.20			
3	1,347.73	84.23			
4	1,859.48	116.22			
5	1,418.38	88.65			
Average	1,671.40	104.46			
Standard Deviation	278.03	17.38			

<u>Conclusion:</u> The individual results are within 20 percent of the average. The shear strength of both type of samples meet the minimum requirement of 50 psi per AC51, section 3.1.3.4.

5.0 CONCLUSION

The Native Custom Stone products described in section 2 of this report meet the requirements and conditions of acceptance for the tests listed in section 3 per the ICC ES AC51 "Acceptance Criteria for Precast Stone Veneer", Approved February 2008, Effective March 1, 2008.

END OF REPORT



6.0 PHOTOGRAPHS

Flexural Strength Test

Tensile Strength Test





Shear Test Sample Fabrication





Shear Test Sample Fabrication





Dimensions & Size per Square Foot Verification





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Moisture Absorption Test



Shear Test







APPENDIX

QCC Sample Selection letter (2 pages)

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