CERTIFIED TEST REPORT

TENSILE AND SHEAR STRENGTH OF POST-INSTALLED ANCHORS IN CONCRETE ELEMENTS

- Per ASTM E488 -

Report Number: R-5.10_03-03-20_PS
Date: June 10, 2020

REPORT PREPARED FOR:

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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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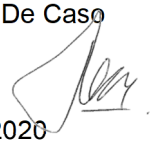
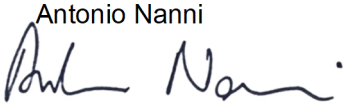
Controls:	
Superseded Report	New report
Reason for Revision	n/a
Effective Date	June 10, 2020

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: June 10, 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: June 10, 2020

1. Strength of Anchors - ASTM E488

1.1. TEST SUMMARY INFORMATION

Test Objective:	Determination of tensile and shear strength of post-installed anchors in test cubes made from dry bagged mortar mixture.
Sample Under Evaluation:	Piazza Stonework bagged mortar mix.
Test Standard Method/s:	ASTM E488/E488M − 18, Standard Test Method for Strength of Anchors in Concrete Elements.
Test Set-up:	For the tensile strength of anchors, the confined setup was used by considering the minimum required clearance between the anchors and test support equivalent to twice the effective embedment length, permitting the unrestricted development of a conical concrete fracture surface. This was accomplished by placing a ½-in. loading ring with an opening of 2- inch diameter on the specimen surface. Uniform contact was provided between the specimen surface and restraining fixture assembly. Anchor installation was on the form-finished specimen surface. The anchor was centered and secured in the locking device and the tensile load was applied concentrically with the anchor axis through the loading rod and perpendicular to the specimen surface. Load was applied under displacement control at 0.05 in./min. Load and frame head displacement were recorded at the sampling rate of once per second. Refer to Figure 1.1. For the shear strength of anchors The anchors were installed through a loading plate with the thickness of ¼ in. to the formed face of the test members. The contact area between the loading plate and test members was 8 in.^{2}. Teflon sheet with a nominal thickness of 0.02 in. was used as friction-limiting material between the loading plate and base material surface, preventing normal reaction between the loading and base. Test specimens were positioned and fastened in the support system so that the test surface of the test member was parallel to the loading plate and the axis of the loading rod assembly. The load was applied parallel to the surface of the test specimen under displacement control of 0.1 in./min. Load and displacement were recorded at the sampling rate of once per second. 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 and Morteza Khatib.
Technical Test Record:	TDS_E488_PS-2.
Specimen Dimensions:	4 in. cube with post installed anchor 1 ¼” x 3/16”.

Specimen Preparation: Test cubes were cast using bagged mortar mixtures per ASTM C192-19 (Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory). A Hilti Kwik Con II 1 ¼" x 3/16" anchor was post-installed using drill bit client instructions.

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 30 days, per client instructions.

Specimen ID: Specimens are labeled and uniquely identified for quality and traceability using the format M_X; where M is the tested property (A-TNS for anchor tensile strength, and A-SHE for anchor shear strength); and X is specimen repetition number (1 to 5). Refer to Table 1.1.

Test Results: Tensile anchor strength, refer to Table 1.2. Shear anchor strength, refer to Table 1.3.

Table 1.1 – Test matrix

Specimen ID	Material Identification	Specimen Preparation (mm.dd.yy)	Test date (mm.dd.yy)
A-TNS_01 to 05	Piazza Stonework bagged mortar mix	03.24.20	04.27.20
A-SHE_01 to 05	Piazza Stonework bagged mortar mix	03.24.20	04.27.20

1.2. TEST RESULTS

Table 1.2 – Tensile anchor strength results

Specimen ID	Embedment Depth		Maximum Load		Failure Mode*
	mm	in.	kN	lbf	
A-TNS_01	19.41	0.764	3.42	769	Tensile – Cone formation
A-TNS_02	19.13	0.753	2.92	656	Tensile – Cone formation
A-TNS_03	19.30	0.760	3.22	725	Tensile – Cone formation
A-TNS_04	19.25	0.758	3.12	701	Tensile – Cone formation
A-TNS_05	19.66	0.774	3.58	804	Tensile – Cone formation
Average			**3.25**	**731**	
S_{n-1}			0.26	58	
CV((%)			7.9	7.9	

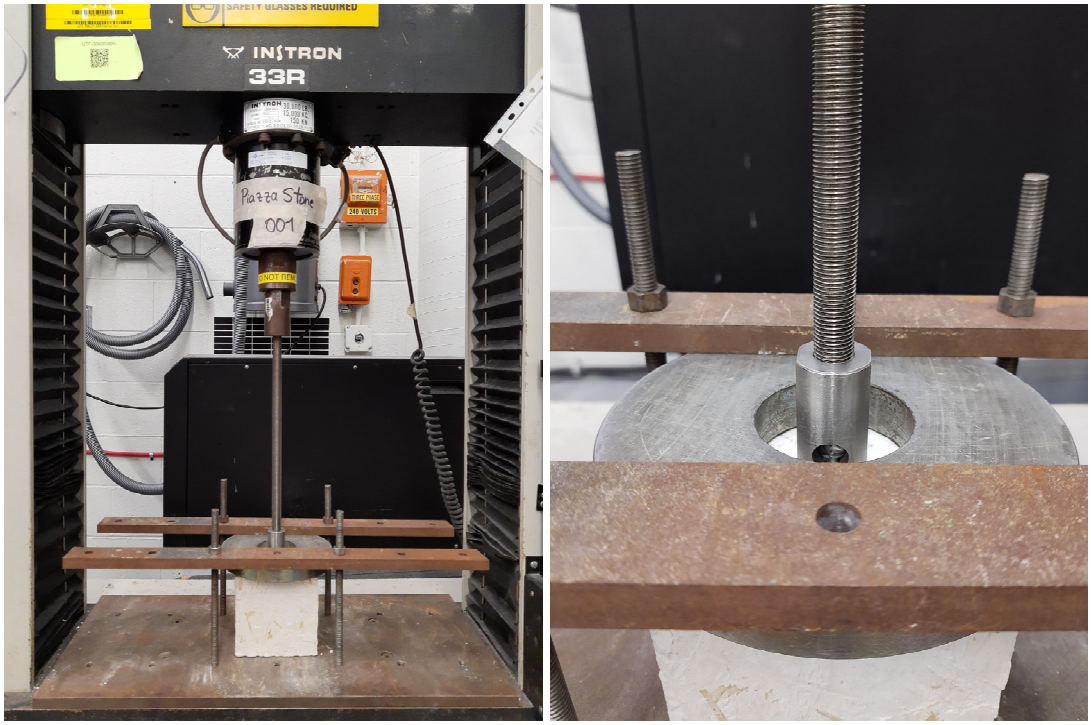
**Refer to Figure 1.2 for representative failure mode.*

Table 1.3 – Shear anchor strength results

Specimen ID	Maximum load		Failure Mode*
	kN	lbf	
A-SHE_01	2.32	521	Shear
A-SHE_02	2.03	456	Shear
A-SHE_03	2.27	510	Shear
A-SHE_04	1.96	440	Shear
A-SHE_05	2.04	459	Shear
Average	**2.12**	**477**	
S_{n-1}	0.16	36	
CV((%)	7.5	7.5	

**Refer to Figure 1.3 for representative failure mode.*

1.3. VISUAL DOCUMENTATION



(a)

(b)

Figure 1.1 – (a) Tensile strength of post-installed anchor test setup, and
(b) Shear strength of post-installed anchor test setup

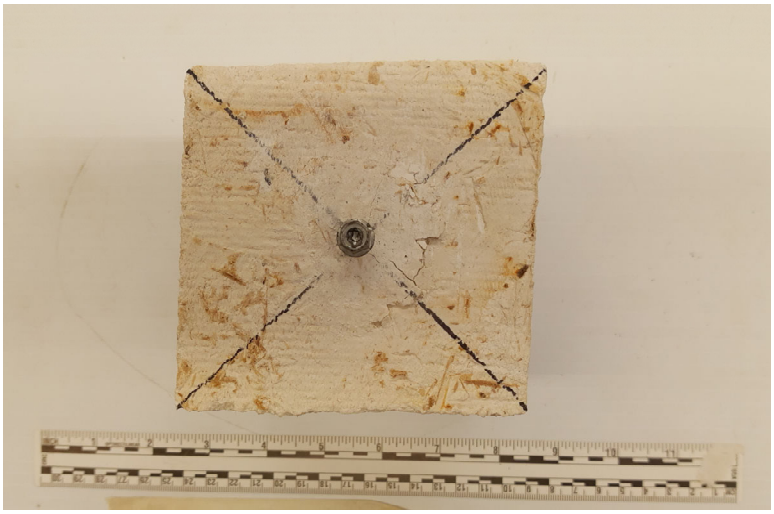


Figure 1.2 – Representative failure mode of anchor tensile strength test

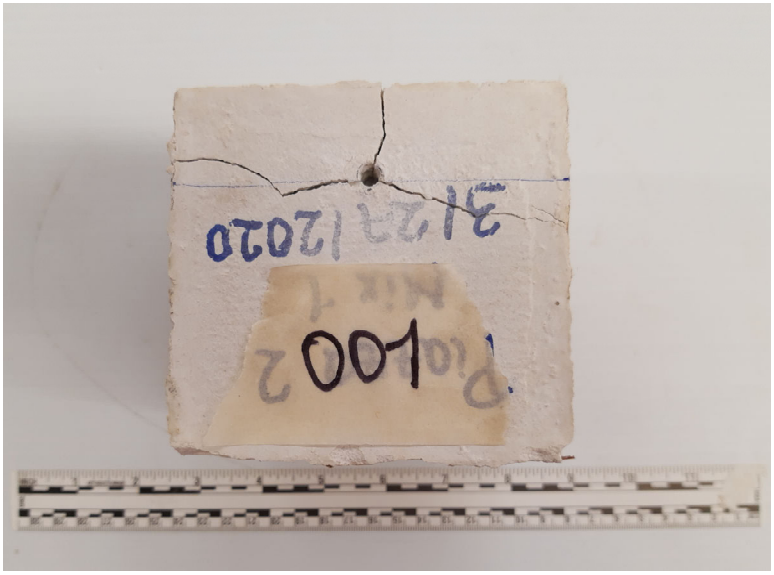


Figure 1.3 – Representative failure mode of anchor shear strength test

♦ END OF TEST REPORT ♦