

SPRINGBOLT CONCRETE ANCHOR LLC

ASTM E488 Fastener Tension Testing using P6R-Green Springbolt Concrete Anchors (Improved Design)

10/30/2017

11/13/2017 - Revised date on cover page.

This test report contains seventeen (17) pages, including the cover sheet. Any additions to, alterations of, or unauthorized use of excerpts from this report are expressly forbidden.

2017-6087 (B)

1. TITLE

ASTM E488 Fastener Tension Testing using P6R-Green Springbolt Concrete Anchors (Improved Design)

2. OBJECTIVE

To determine the tensile capacity of the anchors when embedded in concrete. This data is to be separately used for calculating the allowable strength of the anchor system in accordance with ICC-ES AC446.

This test report pertains only to the specimens tested. It remains the sole responsibility of the manufacturer to provide a product consistent to that which was tested.

3. TESTED FOR

Springbolt Concrete Anchor LLC 4444 Sharpe Road Anacortes, WA 98221

4. TESTING ORGANIZATION

Progressive Engineering Inc.

58640 State Road 15 Goshen, IN 46528 www.p-e-i.com

See IAS Evaluation Report TL-178 for ISO 17025 Accreditation.

5. TESTING PERSONNEL

Director of Testing Technician

- Jason R. Holdeman - Justin Witmer

Jaron R. K____

6. REFERENCE STANDARDS

ICC-ES AC446 - Acceptance Criteria for Headed Cast-In Specialty Inserts in Concrete, (Approved June 2013)

ACI 318-11 - Building Code Requirements for Structural Concrete and Commentary

ASTM E488/E488M - 15 - Standard Test Methods for Strength of Anchors in Concrete Elements

7. TESTING EQUIPMENT

- A. Load Cell (PEI Nos. 863 & 1007)
- B. String Potentiometers (PEI Nos. 639 & 881)
- C. Data Acquisition (PEI No. 643)
- D. Tensile Loading Fixture
- E. 6" Digital Caliper (PEI No. 1004)

8. TEST SPECIMEN

A. Concrete Anchors

P6R Springbolt Concrete Anchor with Green Housing, overall 6" (includes cap and backing plate). The anchor includes; (1) a 5/8" x 4-1/4" long, Grade 5, hot-dipped galvanized square head bolt, with a 2" threaded length, (2) a black plastic housing with a 1-1/2" diameter lower section and a 0.80" diameter upper section that the bolt shank passes through, (3) a Grade 8 retention washer with a 1.5" O.D. and slid over the upper section, (4) a coil spring set inside the lower section and compressed between the bolt head and base plate and (5) a 3" x 3" base plate that snaps to the lower section. See attached drawings and photographs for details.

The specimen drawings were provided to PEI by Springbolt Anchor and were dimensionally verified to the actual test specimens by PEI personnel.

B. Concrete

All-Star 5,000 concrete mix was purchased from Menards for this testing. The concrete was mixed with an electric concrete mixer using (3) three 60 lb bag to 2.5 gallons of water in order to target a 4,000 psi mix, and poured on 10/13/17. Concrete cylinders were taken from each batch in accordance with ASTM C31 procedure for rodding and field curing. The cylinders were covered for the first 3 days and then delivered to Weaver Consulting Group where they were stored with the caps open and tested the compressive strength periodically as directed by PEI. The slabs poured had an average strength of 4,785 psi between 10/27/17 and 10/30/17. See Appendix section of this report for photographs and Weaver Consulting Group test report no. 0038-354-20-00 PH 02 for details.

9. TEST SPECIMEN CONSTRUCTION

- A. A lumber form was constructed so as to create five (5) 30" x 30" concrete slabs for the concrete anchors. The forms were set at a depth of 6" for each anchor, respectively. Four (4) pieces of 3/8" rebar were set around the perimeter of the form approximately 1" in from the sides to reduce/prevent the slab from cracking but in no way affect the anchor performance. The concrete anchor's base plate was fastened to the 1/2" OSB on the bottom of the form using a 1/2" long screw in the holes provided, to prevent shifting during the pouring process. These screws were broken off flush with bottom of the anchor prior to testing.
- B. The concrete was poured into the frames, then the forms were tapped with a hammer around the perimeter to remove voids. PEI personnel finished the surface in a manner that is consistent with industry practice.
- C. Once the concrete was cured to a compressive strength within ±400 psi of the target strength the wooden frame was removed from the concrete slab.
- D. The plastic cap covering the threaded anchor was broken off by chiseling the concrete around the cap using a screw driver. The threaded anchor was then turned using a screw driver until it sprung out of the anchor, as designed.

See attached photographs for further details.

10. TEST SPECIMEN CONDITIONING

The concrete slabs were allowed to cure in lab ambient conditions, typically 70°F and 50% RH, during the curing process and testing process.

11. TEST SET-UP

Tensile Testing - Installed in concrete slab

A square steel tube reaction frame having an inside dimension of 12" was centered around the anchor. The reaction frame provided an unsupported region equivalent to 4 times the effective depth of the anchor in the concrete plus the washer diameter. The tension test machine was set on the reaction frame and consisted of: (1) two (2) hydraulic cylinders, (2) two (2) load cells, (3) a loading channel, (4) and a slotted fixture with a bolt matching the thread size of the test anchor. The test fixture bolt attached to the test machine was connected to the threaded end of the concrete anchor using a coupling nut. Two (2) string pots were positioned on opposite sides of the anchor under a plate attached to the loading channel. The string pots were set relative to the concrete slab outside of the reaction frame.

12. TEST PROCEDURE

Tensile Testing - Installed in concrete slab

The load was applied at a rate that produces an ultimate failure within 1 to 3 minutes. The maximum force attained was recorded along with a failure description as defined in Section 14.2 of ASTM E488 and Section 2.4.7 of ICC-ES AC446.

13. TEST RESULTS

Concrete Anchor	Anchor Weld	Test Type	Tested in Concrete Slab	Average Maximum Force (Ibf)	
P6R Green Housing (Improved Design)	N/A	Tensile	Yes	12,807	

See attached data pages for individual test details.



ASTM E488 Static Concrete Anchor Testing

Client: Springbolt Concrete Anchor LLC Test Specimen: 6" Springbolt Anchor with Green Housing (improved design), with a 5/8" threaded bolt, installed in concrete.

Concrete Pour Date: 10/13/2017 Compressive Strength: 4,785 psi Concrete Slab Dim.: 30" x 30" x 6"

Anchor Install Date: 10/13/2017 Anchor Installed By: Jason Anchor Install Depth: 6" Anchor Effective Embedment Depth: 2-3/8" Anchor Edge Dist.: 15"

Reaction Frame Size (Inner): 12" Square

			Deflection**		
	Sample	Maximum	@ Maximum	***Failure	
	NO.	Load (IDT)	Load (In)	Code	Comments / Observations
	6087-A	13,603	.384	1C, 1A	Anchor pulled out of slab with a shear cone breakout of concrete to reaction frame supports.
	6087-B	12,241	.363	1C, 1A	Anchor pulled out of slab with a shear cone breakout of concrete to reaction frame supports.
	6087-C	12,578	.517	1C, 1A	Anchor pulled out of slab with a shear cone breakout of concrete to reaction frame supports. Failure was attained is less than 30 seconds due to an equipment malfunction.
	6087-D	12,475	.593	1C, 1A	Anchor pulled out of slab with a shear cone breakout of concrete to reaction frame supports.
	6087-E	13,102	.637	1C, 1A	Anchor pulled out of slab with a shear cone breakout of concrete to reaction frame supports.
	Average	12,807	.421		
S	tandard Dev.:	709.2	0.084		
	COV:	5.5%	19.8%		

Tension Test - in Concrete

*Load Rate: 6,000 lbf per minute

Test Date: 10/30/2017

Humidity: 50% RH

Temperature: 73 °F

*Load Rate: Maximum Load in no less than 1 minute or more than 3 minutes per ASTM E488.

**The deflection shown includes some movement resulting from the test fixture and elongation of the threaded rod.

*** - Failure modes can be described as "C" indicates concrete and "A" indicates anchor.

1C - Brittle failure of the structural member (concrete) in the form of a shear cone.

2C - Failure of the structural member (concrete) by cracking that radiates outward from the location of the fastening device, resulting in pull-out of the fastener.

 $\ensuremath{\textbf{3C}}$ - Concrete slab split thru the anchor thru the entire thickness.

1A - Failure of the large barrel material at the just below the washer at the effective embedment depth.

2A - Retention washer cupped / deformed due to nut contact with washer.

3A - Ductile failure of the fastener (tension).



ASTM E488 Static Concrete Anchor Testing

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<u>Progressive Engineering Inc.</u>

Test Sample Construction



Concrete forms with anchors installed



Concrete forms with anchors installed



Concrete finishing

Finished concrete surface



P6R-Green components

P6R-Green components



Test Setup



Test Setup

<u>Progressive Engineering Inc.</u>

P6R-Green Springbolt Tension Test in Concrete Slab



Sample No. 6087-A Failure

Sample No. 6087-A Failure



Sample No. 6087-B Failure

Sample No. 6087-B Failure



Sample No. 6087-C Failure

Sample No. 6087-C Failure

P6R-Green Springbolt Tension Test in Concrete Slab



Sample No. 6087-D Failure

Sample No. 6087-D Failure



Sample No. 6087-E Failure

Sample No. 6087-E Failure



Sample No. 6087-D Anchor Post-Test (Typical)

Sample No. 6087-E Anchor Post-Test (Typical)



APPENDIX

SPRINGBOLT CONCRETE ANCHOR LLC 2017-6087 (B)



October 13, 2017

7121 Grape Road Granger, Indiana 46530 (574) 271-3447 Fax (574) 271-3343 www.wcgrp.com

Report of Concrete Compression Tests

Client: Progressive Engineering 58640 State Road 15 Goshen, Indiana 46528 Project: PEI #R-2 Samples Location: Weaver Consultants No 0038-354-20-00 PH 02

Concrete Supplier:

Ticket Number: Mix Identification:

Placement Location: Specific Location: Date Cast: Truck Number: Mix Type:

			Total Placed	Cumulative	Slump	Air Content	Air Temp	Concrete Temp	Specified Strength	
Set No.	Time Batched	Time Sampled	(CY)	(CY)	(in.)	(%)	(ºF)	(ºF)	(PSI)	Cast By
1	N/A									Others

Lab No.	Date Received	Break Date	Age	Curing	Cylinder Weight (lbs.)	Cyl. Cross Sec. Area (sq. in.)	Break Type *	Total Load (lbs)	Strength (PSI)	Tested By
R2-3 12:25 PM	10/16/2017	10/20/2017	7	Field	8.2	12.6	В	51,500	4,100	JM
R2-6 1:25 PM	10/16/2017	10/23/2017	10	Field	8.3	12.6	В	48,000	3,820	TN
R2-4 12:35 PM	10/16/2017	10/30/2017	17	Field	8.3	12.6	В	60,500	4,810	TN
R2-5 1:00 PM	10/16/2017	10/30/2017	17	Field	8.3	12.6	В	56,500	4,500	TN
R2-1 11:45 AM	10/16/2017	10/27/2017	14	Field	8.5	12.6	В	66,500	5,290	TN
R2-2 12:00 PM	10/16/2017	10/27/2017	14	Field	8.3	12.6	В	57.000	4.540	TN

Remarks:

Contractor Made Cylinders

* Break Type

A : Cone

B : Cone and Split C : Cone and Shear D : Shear

E : Columnar

Applicable Test Methods Compressive Strength Testing per ASTM C39 Cylinders Cast by Other per ASTM C31 Nominal Cyl. Diameter 4 inches

Distribution

jholdeman@p-e-i.com

Respectfully Submitted: Weaver Consultants Group

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