

MCB Industries, Inc.

TEST REPORT

SCOPE OF WORK

Airport in pavement light fixture mounting bolt torque/tension testing.

PROJECT NUMBER

G104067208

REPORT NUMBER

104067208CRT-001A

REPORT ISSUE DATE

September 30, 2019

REPORT REVISION DATE

None



PAGES

19

Project No.: G104067208
Quote No.: Qu-01006311

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REPORT NUMBER
104067208CRT-001A

REPORT RENDERED TO:

MCB INDUSTRIES, INC.
310 N. WISCONSIN, SUITE E
DE PERE, WI 54115
USA

TEST STANDARDS

Federal Aviation Administration Engineering Brief (EB) 83A: In-Pavement Light Fixture Bolts, dated 12/26/2018

TESTING PURPOSE

Determine the design torque of bolts utilized in various in-pavement light fixture configurations on airport runways.

TEST DATES

September 11, 2019 through September 27, 2019

In Charge Of Tests:



Ryan Siddon
Engineering Team Lead
Lighting Division

Report Reviewed By:



Jeremy N. Downs, P.E.
Staff Engineer
Lighting Division

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Sample Log In					
Date Rec.	Intertek ID	Description	Condition	Model No. / Part No.	Photo #
2/15/2019	N/A - Intertek Property	Custom 1A galvanized base flange simulation piece for skidmore wilhelm testing	Undamaged	Jaquith	1
5/22/2019	N/A - Intertek Property	12" L-852 Aluminum in pavement fixture (top only)	Modified for Skidmore-Wilhelm testing/fitting	unmarked	2
9/11/2019	CRT1909111630-001	Batch of 3/8"-16 x 4.5" ASTM F593C <u>SmartBolts®</u> with blue tension indicator - SmartBolts® + Paw Print Head Marking + yield load rating marking of 5.0klbf - Pink Coating	Modified Wedgelock™ bolt mentioned below with blue tension indicator	MCB	3
9/11/2019	CRT1909111630-002	Batch of 3/8"-16 x 4.5" ASTM F593C <u>WedgeLock™</u> Bolts - Paw Print Head Marking - Pink Coating	Undamaged	MCB	4

In-pavement Light System Information	
Light fixture	Aluminum Top
3/8" Bolt	ASTM F593C
Bolt coating	Pink Coating
Two-part locking washer	N/A - Wedgelock™ bolt has integrated washer
L-868 light base (Class 1A or Class 1B):	Class 1A
Accessories or modifications	Smartbolt® has blue tension indicator

Sample Photos

Photo #1



Photo #2

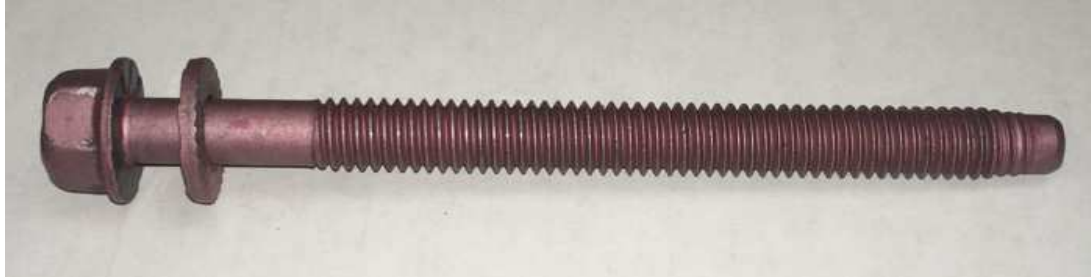


Photo #3



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Photo #4



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Test Plan and Datasheets			
Client	MCB Industries, Inc.	Engineer	Ryan Siddon
Report #	104067208CRT-001A	Reviewer	Jeremy N. Downs, P.E.
Product	In-pavement light fixture system	Model(s)	Various - see sample page
Standard	FAA EB83A		

Spec	Test name	Clause	Pass Fail N/A
EB83A	Bolt Tension Calibrator	N/A	N/A
N/A	Tension vs. Torque	N/A	N/A
N/A	Stress vs. Strain	N/A	N/A

Bolt Type	Yield Strength (psi)	Proof Load (psi)	Tensile Strength (psi)	Stress Areas (in ²)	Yield Load (lbs)	Proof Load (lbs)	75% of Yield Load (lbs)	Ultimate Load (lbs)
3/8" ASTM F593C Grade 304 SS	65,000	55,250	100,000	0.0775	5,038	4,282	3,778	7,750
			150,000					11,625

Notes:

Proof Load values of ASTM bolts are calculated and is approximately 85% of the yield point.

1.0 Bolt Tension Calibrator Testing

The test bolts were assembled in the Skidmore-Wilhelm Bolt Tension Calibrator with the two-part lock washers, simulated light base extension sections, and simulated light fixture sections. The bolts were then tightened in 5ftlb increments up to 75% of the bolt's yield load. The corresponding force versus torque results were recorded, and the friction coefficient was calculated using the equation $T=K*D*FP$. Any accessories or modifications to the pieces of the configurations were used and/or made to simulate the exact configuration in the field.

Test Setup



Skidmore-Wilhelm set up



Summary Of Tests

Fixture	Base	Bolt	Bolt Length (in)	Spacers	Torque (in-lbs)	Clamping Force (lbs)*
Al	1A	F593C	4.5	0	563	3800

*Note: 3800lbs was used due to resolution of the pressure gauge.

1.0 (a) Bolt Tension Calibrator Testing

The objective was to torque the SmartBolts® to 75% of their yield strength and find an average torque value to be used across the field. 3800lbs was used instead of 3778lbs due to gauge resolution. Photos of the Tension indicator were taken at 75% of yield.

Testing Configuration	1A Base flange piece (New #1), F593C SmartBolt®, Al fixture piece (new)
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Bolt Serial # 1000-005			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	900	0.356
180	15.0	1500	0.320
240	20.0	2050	0.312
300	25.0	2500	0.320
360	30.0	2900	0.331
420	35.0	3300	0.339
480	40.0	3600	0.356
490	40.8	3800	0.344
Average K			0.335



Bolt Serial # 1000-007			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	800	0.400
180	15.0	1300	0.369
240	20.0	1800	0.356
300	25.0	2200	0.364
360	30.0	2600	0.369
420	35.0	3000	0.373
480	40.0	3300	0.388
540	45.0	3800	0.379
Average K			0.375



Bolt Serial # 1000-009			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	900	0.356
180	15.0	1400	0.343
240	20.0	1800	0.356
300	25.0	2150	0.372
360	30.0	2550	0.376
420	35.0	2900	0.386
480	40.0	3350	0.382
540	45.0	3650	0.395
570	47.5	3800	0.400
Average K			0.365



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Bolt Serial # 1000-006			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	800	0.400
180	15.0	1300	0.369
240	20.0	1750	0.366
300	25.0	2100	0.381
360	30.0	2550	0.376
430	35.8	2900	0.395
480	40.0	3100	0.413
540	45.0	3500	0.411
662	55.2	3800	0.465
Average K			0.397



Bolt Serial # 1000-008			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	800	0.400
180	15.0	1200	0.400
240	20.0	1700	0.376
300	25.0	2100	0.381
360	30.0	2550	0.376
420	35.0	3000	0.373
480	40.0	3250	0.394
540	45.0	3700	0.389
560	46.7	3800	0.393
Average K			0.387



Testing Configuration	1A Base flange piece (New #2), F593C SmartBolt®, Al fixture piece (Same as previous 5 bolts)
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Bolt Serial # 1000-010			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	700	0.457
180	15.0	1200	0.400
240	20.0	1600	0.400
300	25.0	2000	0.400
360	30.0	2300	0.417
420	35.0	2700	0.415
480	40.0	3000	0.427
540	45.0	3300	0.436
728	60.7	3800	0.511
Average K			0.429



Bolt Serial # 1000-003			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	1000	0.320
180	15.0	1500	0.320
240	20.0	2000	0.320
300	25.0	2400	0.333
360	30.0	2800	0.343
420	35.0	3150	0.356
480	40.0	3650	0.351
510	42.5	3800	0.358
Average K			0.338



Bolt Serial # 1000-011			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	900	0.356
180	15.0	1350	0.356
240	20.0	1750	0.366
300	25.0	2200	0.364
360	30.0	2600	0.369
420	35.0	3050	0.367
480	40.0	3400	0.376
535	44.6	3800	0.375
Average K			0.366



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Bolt Serial # 1000-004			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	900	0.356
180	15.0	1400	0.343
240	20.0	1850	0.346
300	25.0	2200	0.364
360	30.0	2650	0.362
420	35.0	3100	0.361
480	40.0	3500	0.366
520	43.3	3800	0.365
Average K			0.358



Bolt Serial # 1000-013			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	800	0.400
180	15.0	1350	0.356
240	20.0	1800	0.356
300	25.0	2200	0.364
360	30.0	2650	0.362
420	35.0	3100	0.361
480	40.0	3600	0.356
515	42.9	3800	0.361
Average K			0.364



Average Torque (All Bolts) @ 3800lbs (in-lbs)	563
Standard Deviation of Torque Values (All Bolts)	75.0

1.0 (b) Bolt Tension Calibrator Testing

The objective was to torque the WedgeLock™ bolts to the calculated average torque from section 1.0(a) above to verify the clamping force of 75% of the yield load (lbs). 560in-lbs was used instead of the calculated 563in-lbs due to torque wrench resolution.

Testing Configuration	1A Base flange piece (Used #1), F593C WedgeLock™, Al fixture piece (New from previous testing)
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Bolt	Torque	Torque	Tension
	T (in-lbs)	T (ft-lbs)	Fp (lbs)
1	560	46.7	3850
2	560	46.7	3500
3	560	46.7	3500

Testing Configuration	1A Base flange piece (Used #2), F593C WedgeLock™, Same Al fixture piece as previous 3 bolts
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Bolt	Torque	Torque	Tension
	T (in-lbs)	T (ft-lbs)	Fp (lbs)
4	560	46.7	3400
5	560	46.7	3550
6	560	46.7	3600

Testing Configuration	1A Base flange piece (New #3), F593C WedgeLock™, Same Al fixture piece as previous 6 bolts
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Bolt	Torque	Torque	Tension
	T (in-lbs)	T (ft-lbs)	Fp (lbs)
7	560	46.7	3350
8	560	46.7	3400
9	560	46.7	3450

1.0 (c) Bolt Tension Calibrator Testing

The objective was to torque the SmartBolts® and WedgeLock™ bolts to 75% of their yield strength and find the corresponding torque values.

Testing Configuration	1A Base Flange Piece (Used #3), F593C WedgeLock™. Same AI fixture piece as previous 9 bolts
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Bolt	Torque	Torque	Tension
	T (in-lbs)	T (ft-lbs)	Fp (lbs)
10	620	51.7	3800
11	664	55.3	3800
12	670	55.8	3800

Testing Configuration	1A Base Flange Piece (Used #3), F593C SmartBolt®. Same AI fixture piece as previous 10 bolts
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Bolt Serial #	Torque	Torque	Tension
	T (in-lbs)	T (ft-lbs)	Fp (lbs)
1000-01	652	54.3	3800

Complies: N/A					
Tested By:	Ryan Siddon	Signature or initials:	<i>RWS</i>	Comp. Date	9/11/19
Reviewed By:	JND	Signature or initials:	<i>JND</i>		
Test Equipment Used:	1 2 3 4	Sample No:	various - see sample page		
Amb (°C):	23.3	RH%	64.4		

2.0 Tension vs. Torque

The test bolts were assembled in the Skidmore-Wilhelm Bolt Tension Calibrator with the two-part lock washers, simulated light base extension sections, and simulated light fixture sections. The bolts were then tightened in 5ftlb increments or as close to this value as possible until ultimate failure. The corresponding force versus torque results were recorded, and the friction coefficients were calculated using the equation $T=K*D*FP$. Any accessories or modifications to the pieces of the configurations were used and/or made to simulate the exact configuration in the field. Tension vs. Torque graphs were then created to show the results. The test set-up is the same as testing in section 1.0

Results of Tests

Testing Configuration	1A Base flange piece (Used #3), F593C WedgeLock™, Al fixture piece (from 1.0b and 1.0c)
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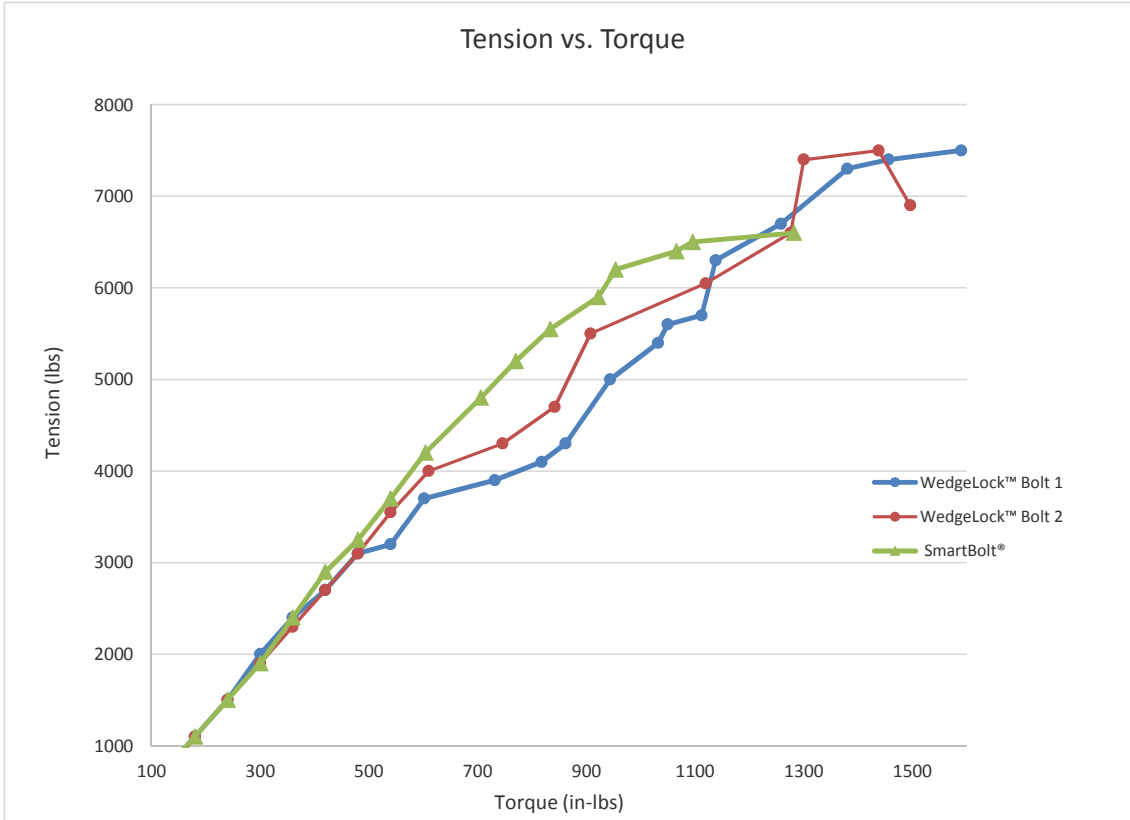
WedgeLock™ Bolt 1			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	700	0.457
180	15.0	1100	0.436
240	20.0	1500	0.427
300	25.0	2000	0.400
360	30.0	2400	0.400
420	35.0	2700	0.415
480	40.0	3100	0.413
540	45.0	3200	0.450
602	50.2	3700	0.434
732	61.0	3900	0.501
818	68.2	4100	0.532
862	71.8	4300	0.535
944	78.7	5000	0.503
1032	86.0	5400	0.510
1050	87.5	5600	0.500
1112	92.7	5700	0.520
1138	94.8	6300	0.482
1258	104.8	6700	0.501
1380	115.0	7300	0.504
1456	121.3	7400	0.525
1590	132.5	7500	0.565

WedgeLock™ Bolt 2			
Torque	Torque	Tension	K
T (in-lbs)	T (ft-lbs)	Fp (lbs)	
120	10.0	600	0.533
180	15.0	1100	0.436
240	20.0	1500	0.427
300	25.0	1900	0.421
360	30.0	2300	0.417
420	35.0	2700	0.415
480	40.0	3100	0.413
540	45.0	3550	0.406
610	50.8	4000	0.407
746	62.2	4300	0.463
842	70.2	4700	0.478
908	75.7	5500	0.440
1120	93.3	6050	0.494
1276	106.3	6600	0.516
1300	108.3	7400	0.468
1438	119.8	7500	0.511
1496	124.7	6900	0.578

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Testing Configuration	1A Base flange piece (Used #3), F593C SmartBolt®, Al fixture piece (from 1.0b and 1.0c)
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SmartBolt® (Serial # 1000-005)			
Torque T (in-lbs)	Torque T (ft-lbs)	Tension Fp (lbs)	K
120	10.0	700	0.457
180	15.0	1100	0.436
240	20.0	1500	0.427
300	25.0	1900	0.421
360	30.0	2400	0.400
420	35.0	2900	0.386
480	40.0	3250	0.394
540	45.0	3700	0.389
604	50.3	4200	0.383
706	58.8	4800	0.392
770	64.2	5200	0.395
834	69.5	5550	0.401
922	76.8	5900	0.417
954	79.5	6200	0.410
1066	88.8	6400	0.444
1096	91.3	6500	0.450
1282	106.8	6600	0.518



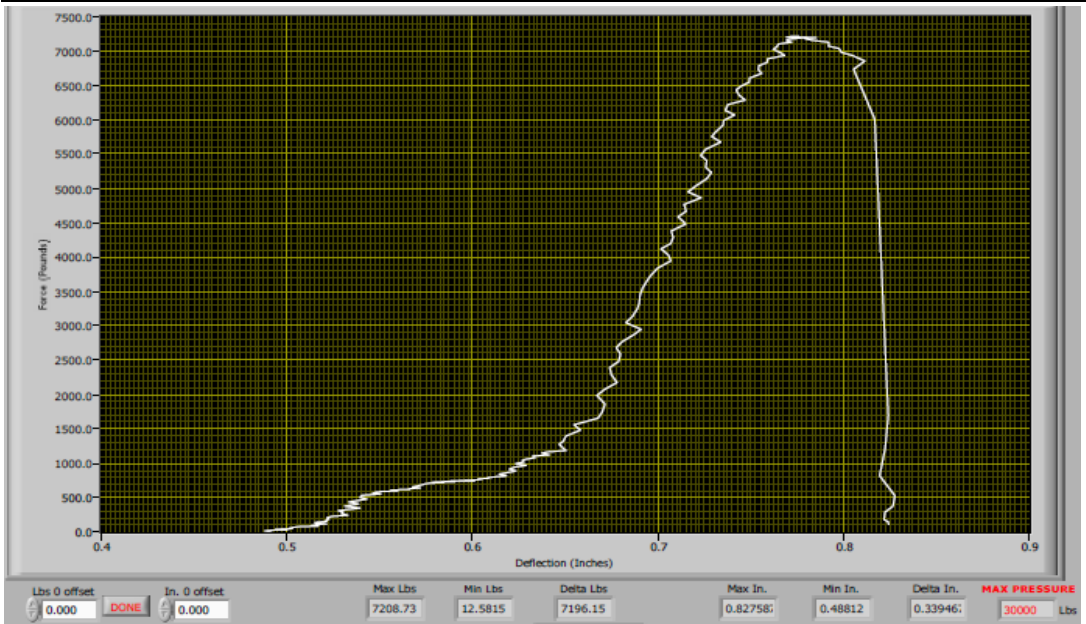
Complies:	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input checked="" type="checkbox"/> N/A		
Tested By:	Ryan Siddon		Signature or initials:	<i>RWS</i>	Comp. Date
Reviewed By:	JND		Signature or initials:	<i>JND</i>	
Test Equipment Used:	1 3 4 7		Sample No:	various - see sample page	
Amb (°C):	23.0	RH%	62.0		

3.0 Stress vs. Strain

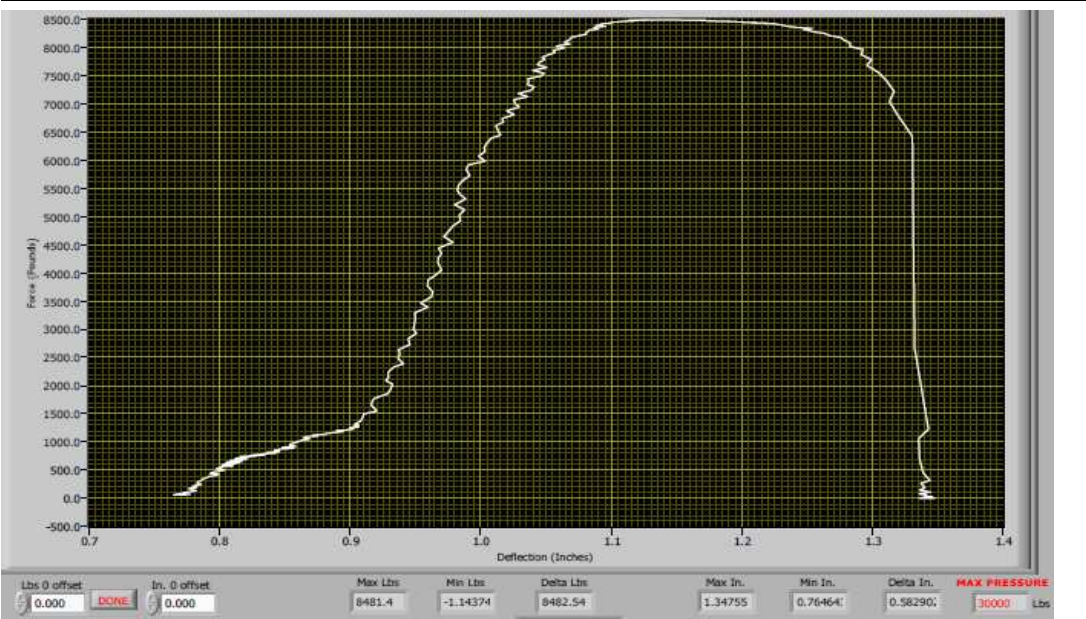
The test bolts were subjected to a tensile load until failure using a Tinius Olsen compressive/tensile load machine until failure. A stress vs. strain relationship curve was plotted to show the yield and ultimate stress points of the bolt.

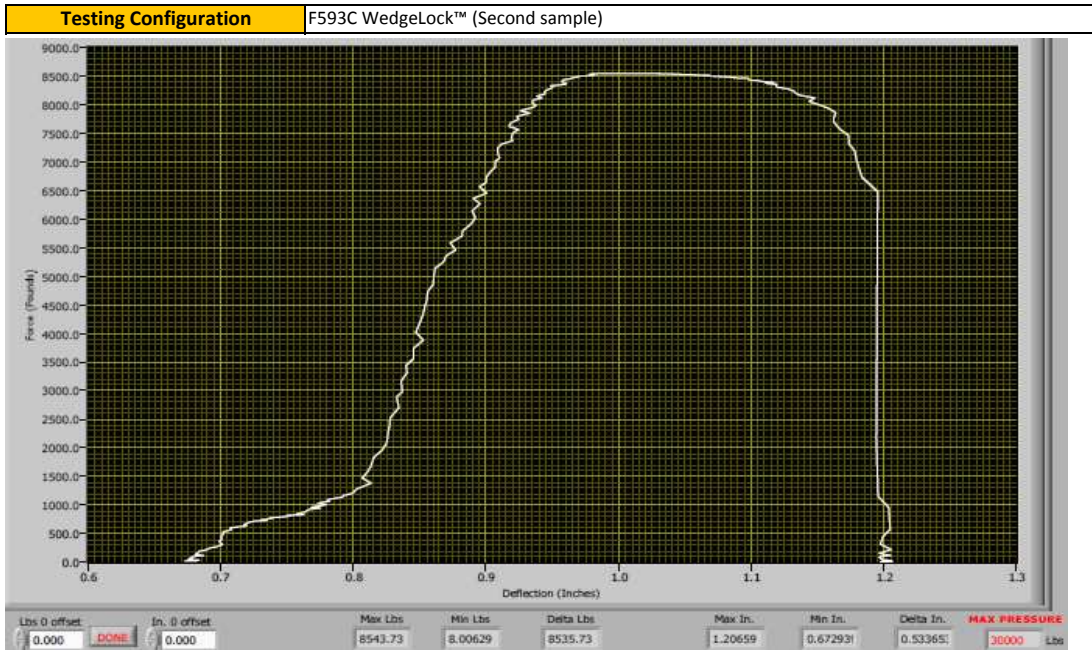
Results of Tests

Testing Configuration F593C SmartBolt® (Serial 1000-004)



Testing Configuration F593C WedgeLock™ (First sample)





Complies: <input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A			
Tested By:	S. Hammond	Signature or initials:	S.H. Comp. Date 9/23/19
Reviewed By:	JND	Signature or initials:	JND
Test Equipment Used:	S,6	Sample No:	various - see sample page
Amb (°C):	23.9	RH%	62.1

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Equipment List				
#	Intertek ID No.	Description	Manufacturer	Calibration Due Date
1	M278	Dial Torque Wrench	CDI Torque Products	12/24/2019
2	M283	6" Digital Calipers	Mitutoyo	4/22/2020
3	n/a	Torque/Tension Calibrator	Skidmore-Wilhelm	1/22/2020
4	M281	Digit Hygro-Thermometer	Testo	4/24/2020
5	S108	Hydraulic Tester	Tinius Olsen	4/30/2020
6	L190	Thermo-Hygrometer	Testo	2/26/2020
7	M279	Digital Torque Wrench	KTC	2/8/2020
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Note: For measurement uncertainty, refer to the calibration certificates for all test equipment.