APPLIED TECHNICAL SERVICES

ISO 9001

1049 Triad Court, Marietta, Georgia 30062 • (770) 423-1400 Fax (770) 424-6415

STAINLESS-STEEL CONNECTION BRACKET TESTING

ATS JOB # 411882-R1

PURCHASE ORDER # CC

Prepared for

NORTHFORD STRUCTURAL CONNECTIONS
105 BARCLAY ST.
NEW HAVEN, CT 06519

*Prepared by*_____ 2024.05.01 11:41:29 -04'00'

Joshua Baldwin, Special Testing Engineer

*Reviewed by*_____ Date: 2024.05.01 12:54:44 -04'00'

Daniel Pate, Special Testing Engineer

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TEST REPORT

Samples

QTY (2) Stainless-Steel Connection Brackets identified by client as A and B.

Test Procedure

Four testing configurations were assembled for various loading directions: in-plane shear, out-of-plane shear, in-plane shear with tension, and tension/compression. The samples were mounted on concrete slabs, then assembled on roller bearing sleds for the specified orientation. The concrete slabs rested on two sleds: one was dynamic (actively moving during the test) and the other was static (stationary). The dynamic plate had a hydraulic actuator mounted on the rear that induced motion and acquired data. All tests had a maximum load potential of 10,000 lbf due to hardware limitations and all cyclic tests used a sinusoidal waveform for the specified loads until failure.

The In-Plane Shear Test consisted of two concrete blocks laying perpendicular to the line of action of motion. The blocks were secured via threaded rods and steel angles. As the hydraulic cylinder oscillated from peak load to zero, a shear force developed within the bracket. The Out-of-Plane Shear Test utilized the same concept as the In-Plane-Shear Test, except the blocks were rotated 90° to simulate vertical motion. The In-Plane Shear with Tension configuration was identical to the In-Plane Shear configuration with the addition of a side load perpendicular to the dynamic plate. The Tension/Compression Test consisted of rotating the blocks 90° planarly from the In-Plane Shear Test; the test specimens were loaded quasi-statically until failure.

The testing consisted of two brackets developed and designed by Northford Structural Connections and were assembled at the testing facility. Tension Control Bolts were used to connect the two sides together across the slabs, and were Skidmore Tested. The brackets were mounted to the slabs using concrete anchors that were torqued to 35 ft-lbf (per Hilti Anchor Fastening Technical Guide, Edition 19). The two brackets, referred to as ‘A’ and ‘B’, were each tested in three configurations, with two being non-destructive load tests. The Tension and Compression Test had a displacement parameter of 0.125″ in both directions. The Out-of-Plane Shear Test was quasi-static loading, where the samples were loaded to 1,000 lbf. The In-Plane Shear Test had a set parameter of ±4,000 lbf for 10 cycles, then was loaded to failure.

Figures 1–11 show the testing configurations, Figure 12 shows crack propagation on the surface of the concrete slabs that occurred, Tables 1–3 list the results from testing, and Figures 13–22 show the data acquisition. Diagram of the samples can be found in the appendix. Testing was performed in ambient temperature and humidity conditions.

Testing Equipment

The samples were tested with an 11-kip fatigue frame (ATS-06172), a 5.5-kip load cell (ATS-06705), a dial torque wrench (ATS-06803), and a 126-kip bolt tension tester (ATS-07817).

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

Testing Configurations

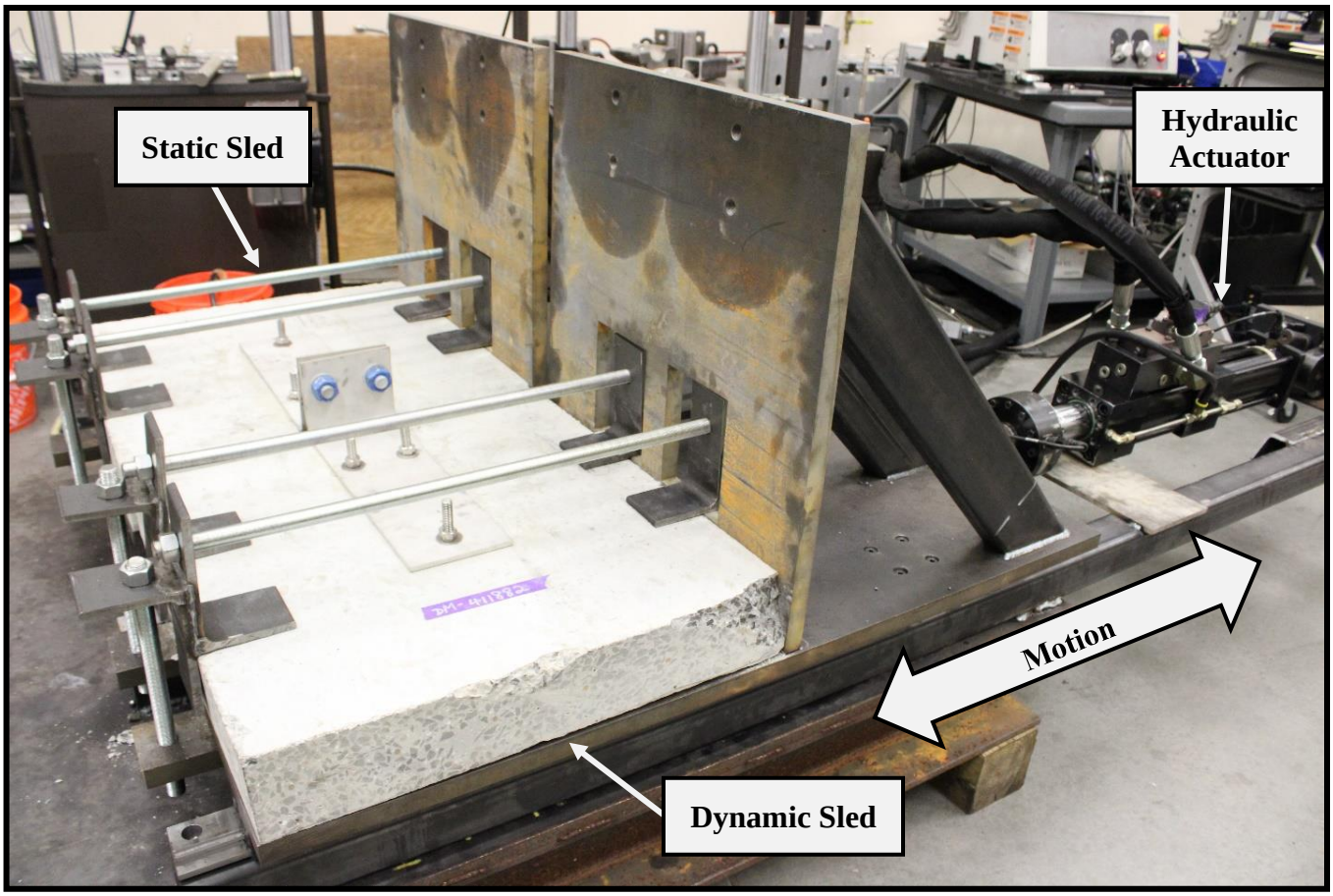

Figure 1: In-Plane Shear Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

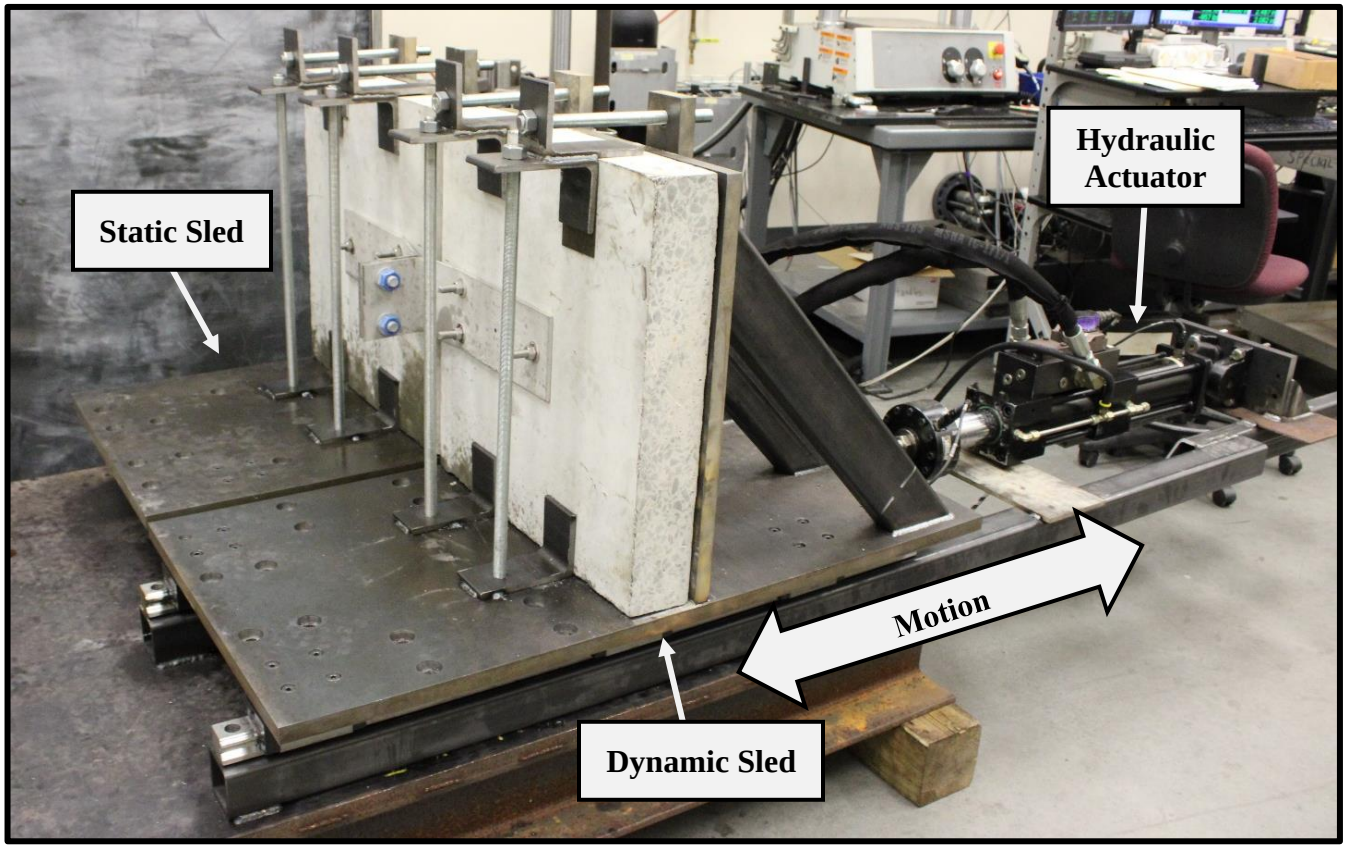

Figure 2: Out-of-Plane Shear Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

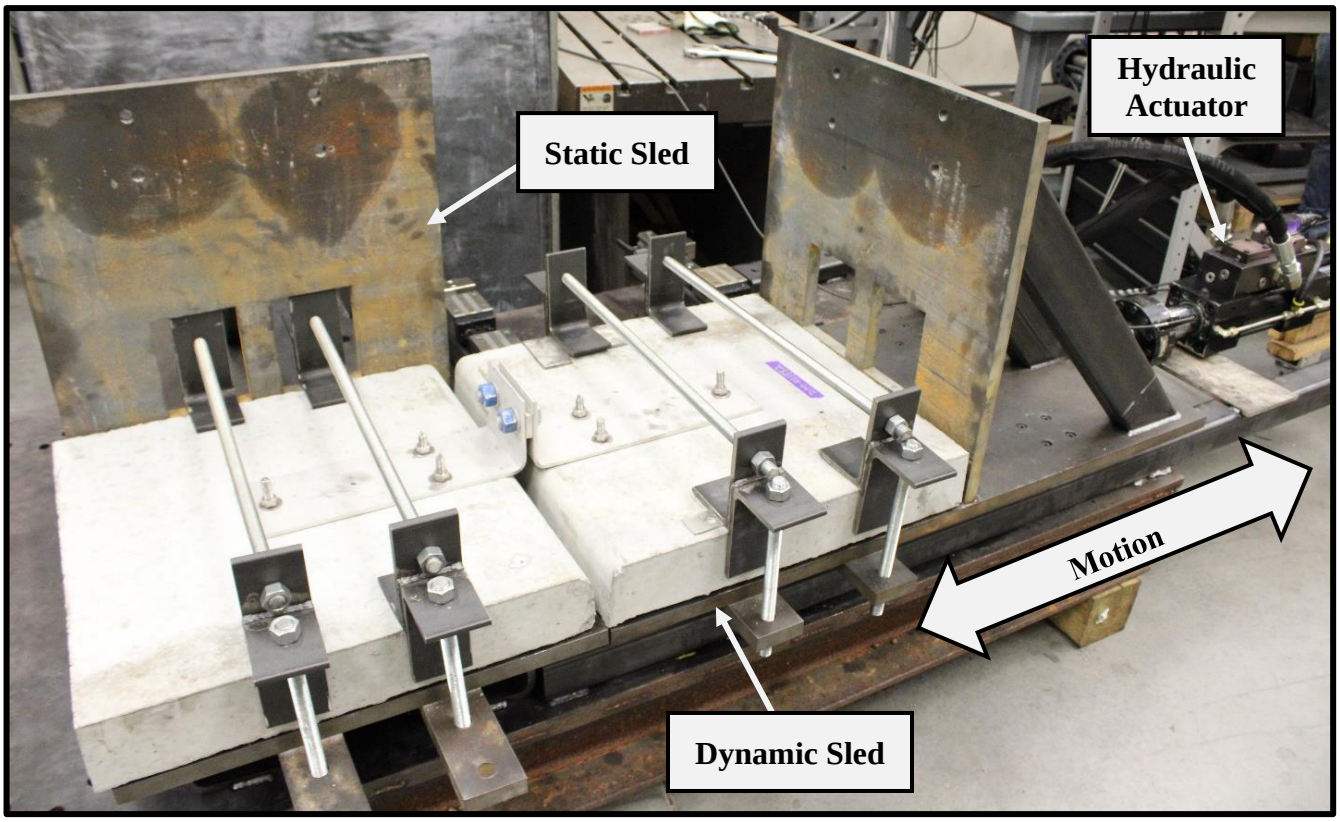

Figure 3: Tension and Compression Test configuration

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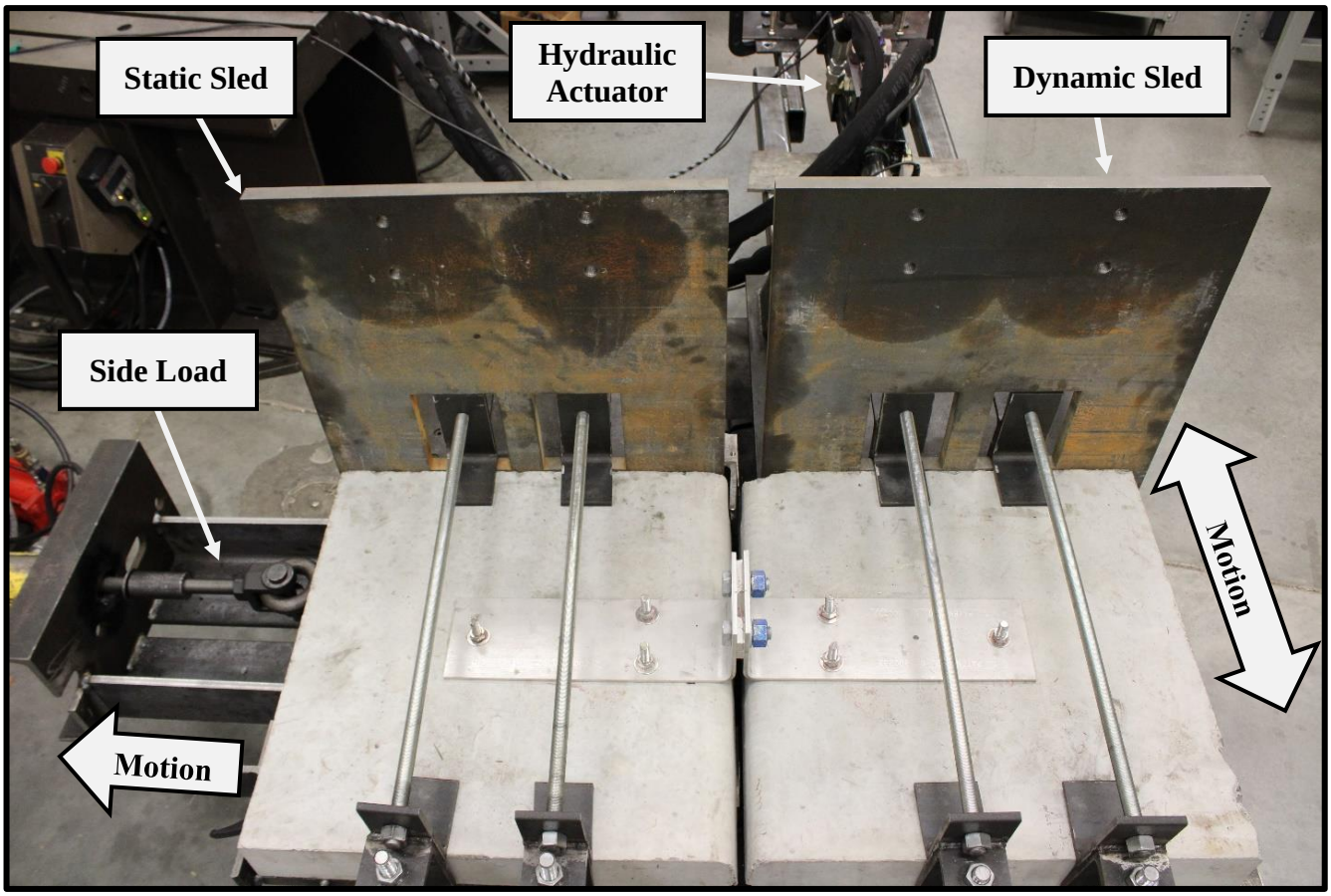

Figure 4: In-Plane Shear with Tension Test configuration

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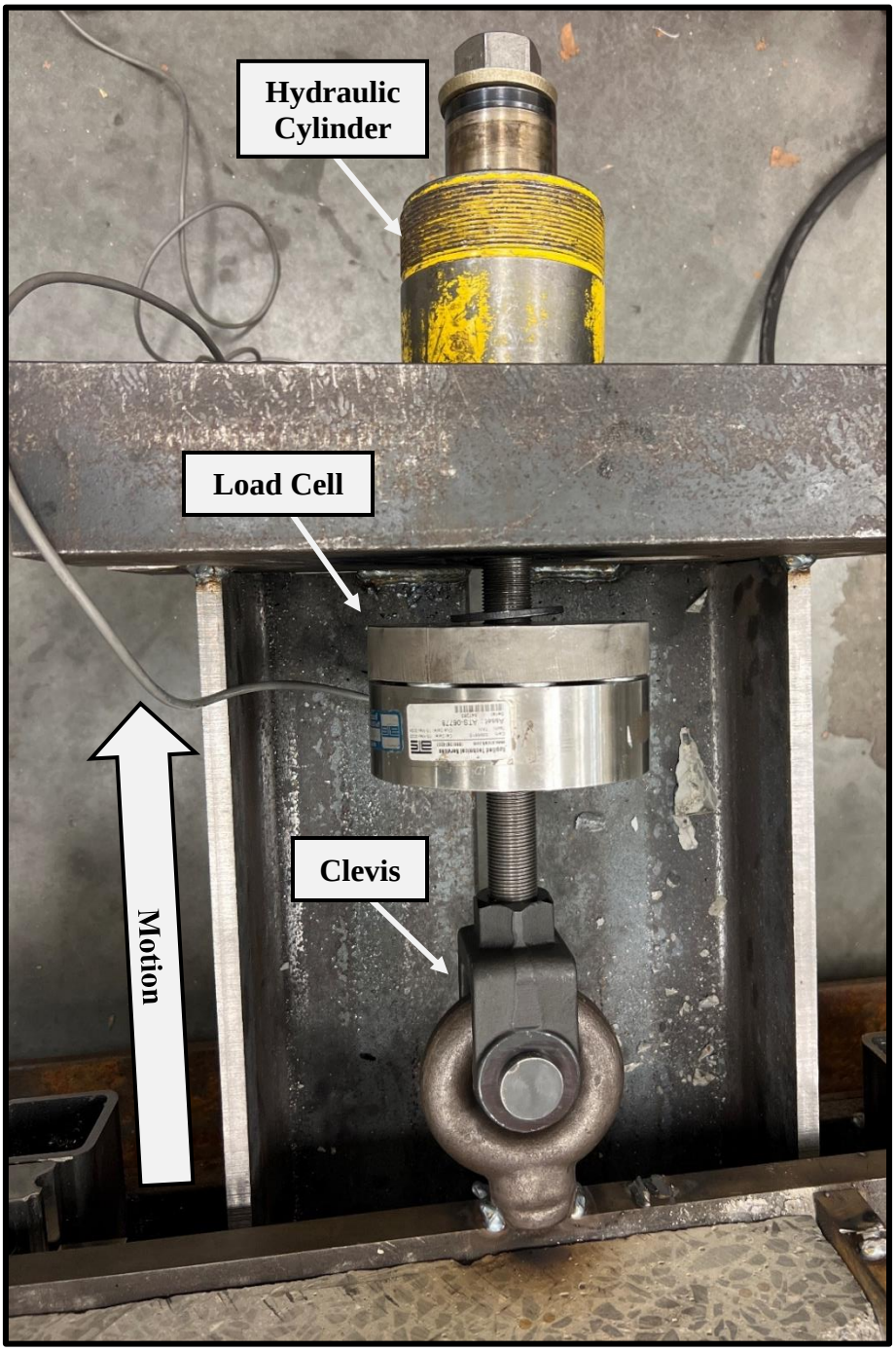

Figure 5: Side load configuration

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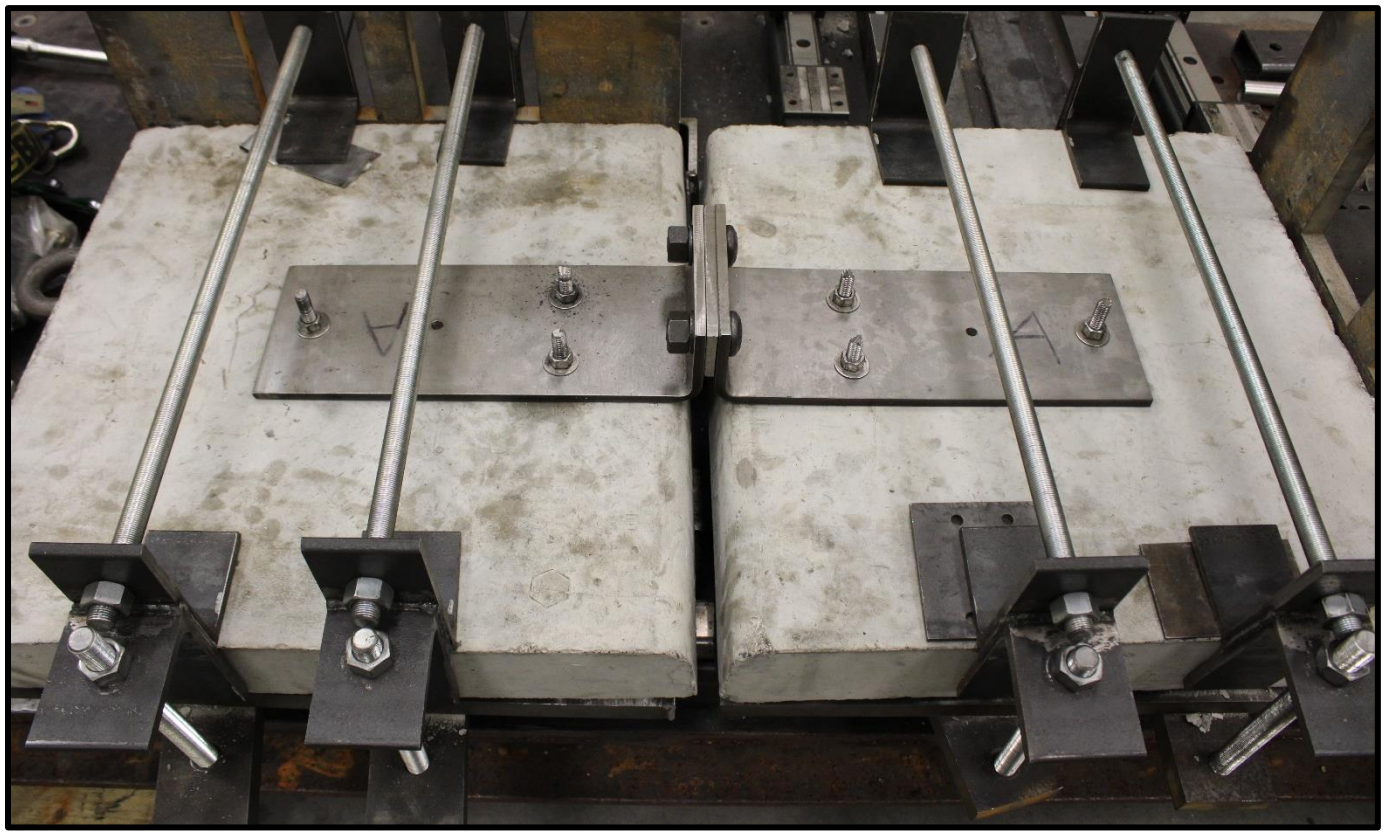

Figure 6: Bracket A - Tension and Compression Test configuration

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TEST REPORT

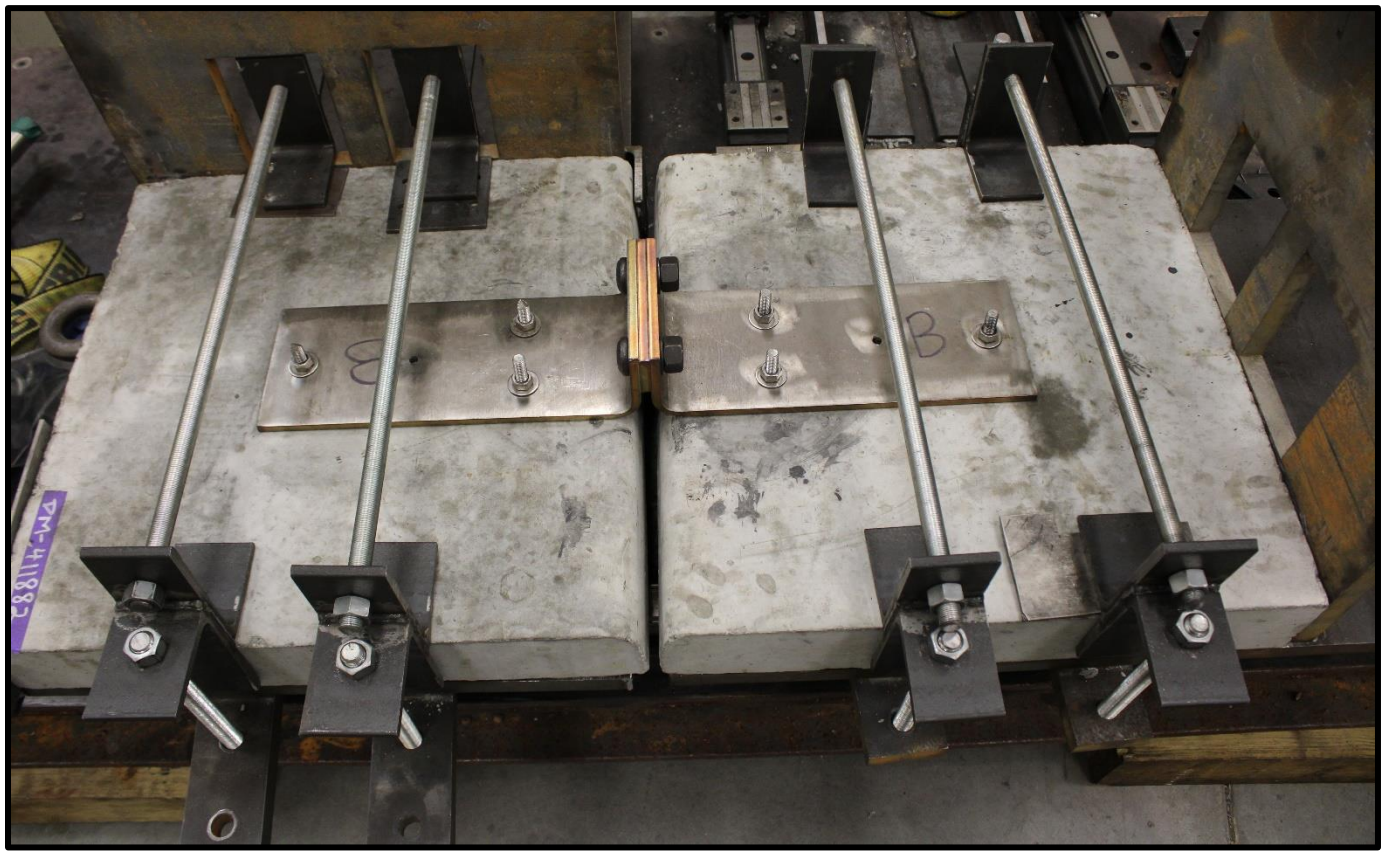

Figure 7: Bracket B - Tension and Compression Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

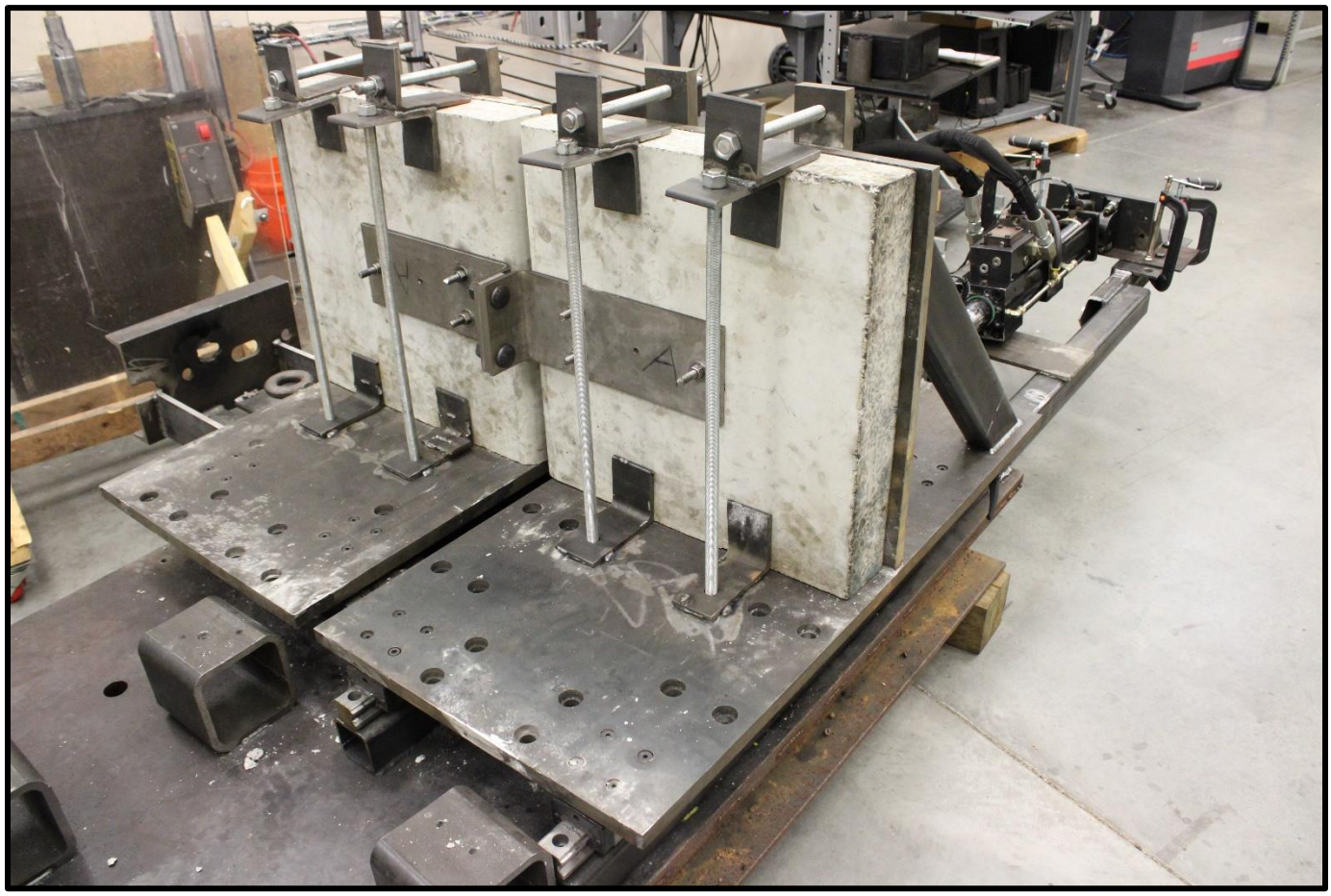

Figure 8: Bracket A - Out-of-Plane Shear Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

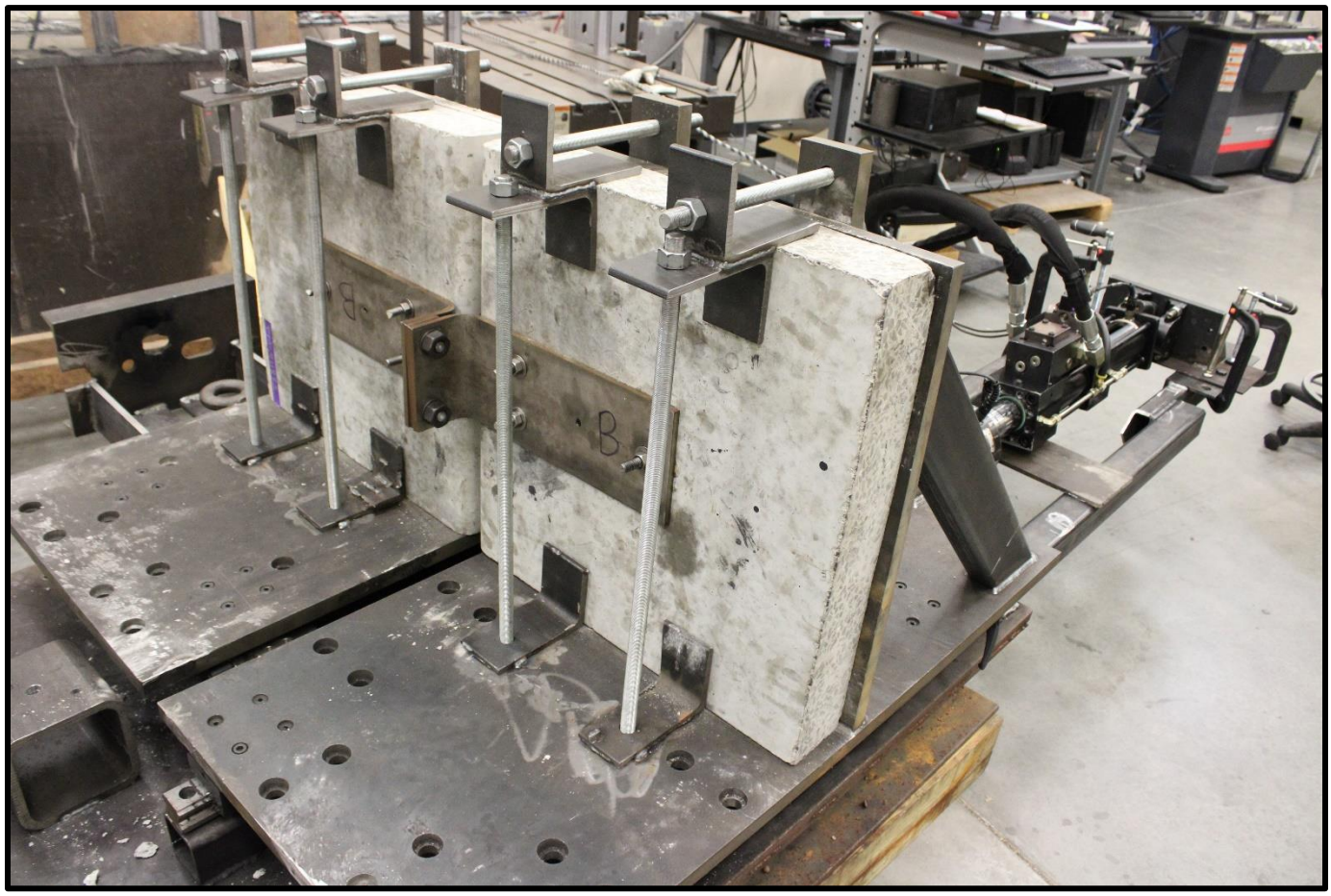

Figure 9: Bracket B - Out-of-Plane Shear Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

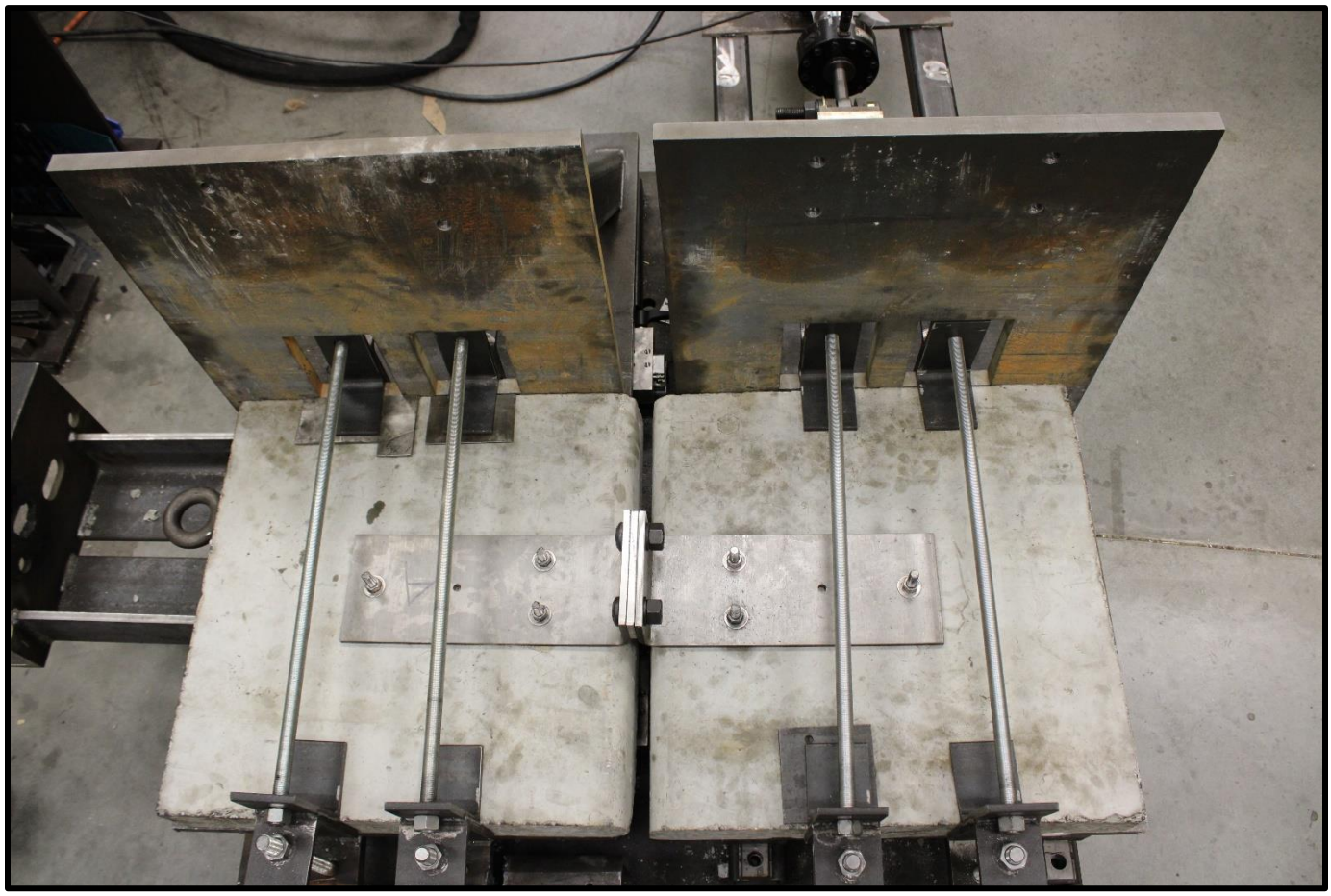

Figure 10: Bracket A - In-Plane Shear Test configuration

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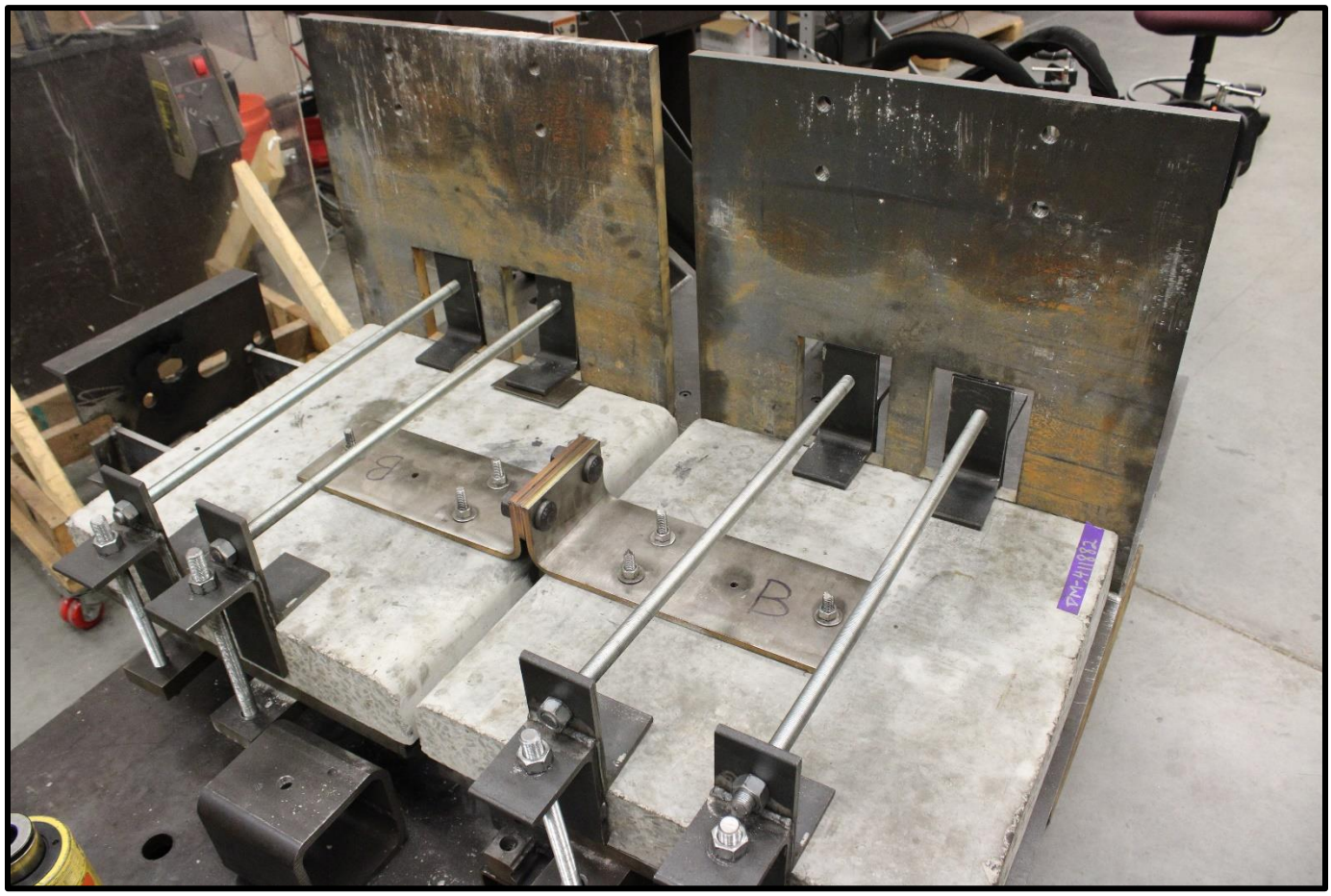

Figure 11: Bracket B - In-Plane Shear Test configuration

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

Results

Table 1: Skidmore Testing results of Tension Control Bolts

3/4″ TC A325 Structural Bolts	
Sample Bolt #	**Tension Load (kips)**
1	37
2	36
3	37
4	36

Table 2: Results of Cyclic Tests

Bracket	Test	Total Cycles	Maximum Load (lbf)	Displacement at Max Load (in)	Observations
A	In-Plane Shear	10	9,942	2.43	Concrete fracturing and crack propagation prevented the sample from reaching 10,000 lbf. Maximum displacement reached was 2.71″.
B	In-Plane Shear	10	10,113	1.99	Concrete fracturing created noise in the data acquisition. Maximum displacement reached was 2.00″.

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Table 3: Results of Quasi-Static Tests

Bracket	Test	Maximum Load (lbf)	Maximum Displacement (in)	Observations
A	Tension	2,413	0.125	During the Tension and Compression Tests, the brackets successfully reached the target displacement of ±0.125″. During the Out-of-Plane Shear Tests, the brackets successfully reached the target load of 1,000 lbf.
A	Compression	-2,731	-0.125	
A	Out-of-Plane Shear	1,000	0.341	
B	Tension	1,343	0.125	
B	Compression	-3089	-0.125	
B	Out-of-Plane Shear	1,000	0.271	

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

Figure 12: Visible crack formation on the concrete slabs after bringing Bracket B to 10,000 lbf during In-Plane Shear Test

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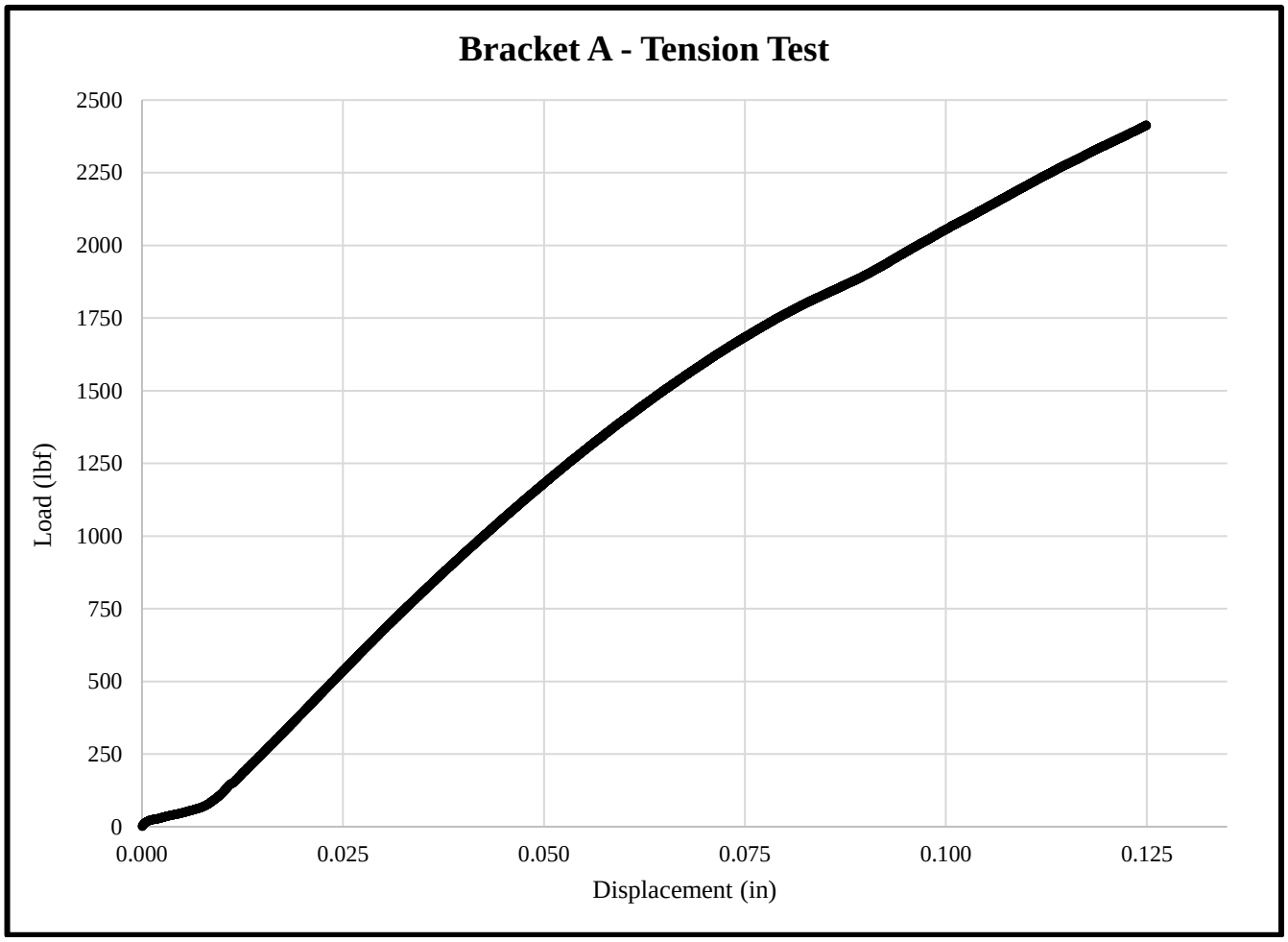

Figure 13: Bracket A - Tension Test data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

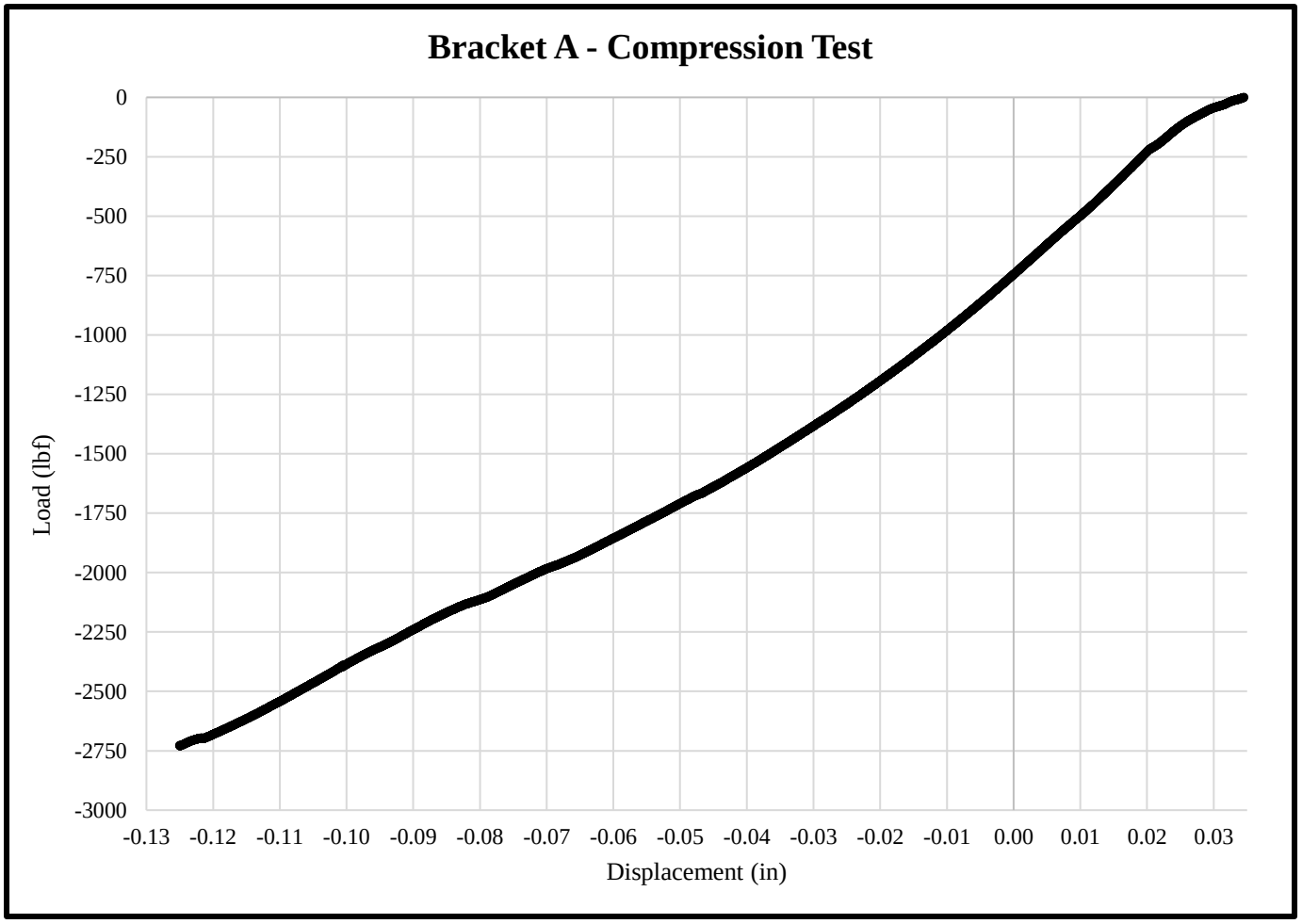

Figure 14: Bracket A - Compression Test data acquisition. Started immediately after Bracket A's Tension Test.

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

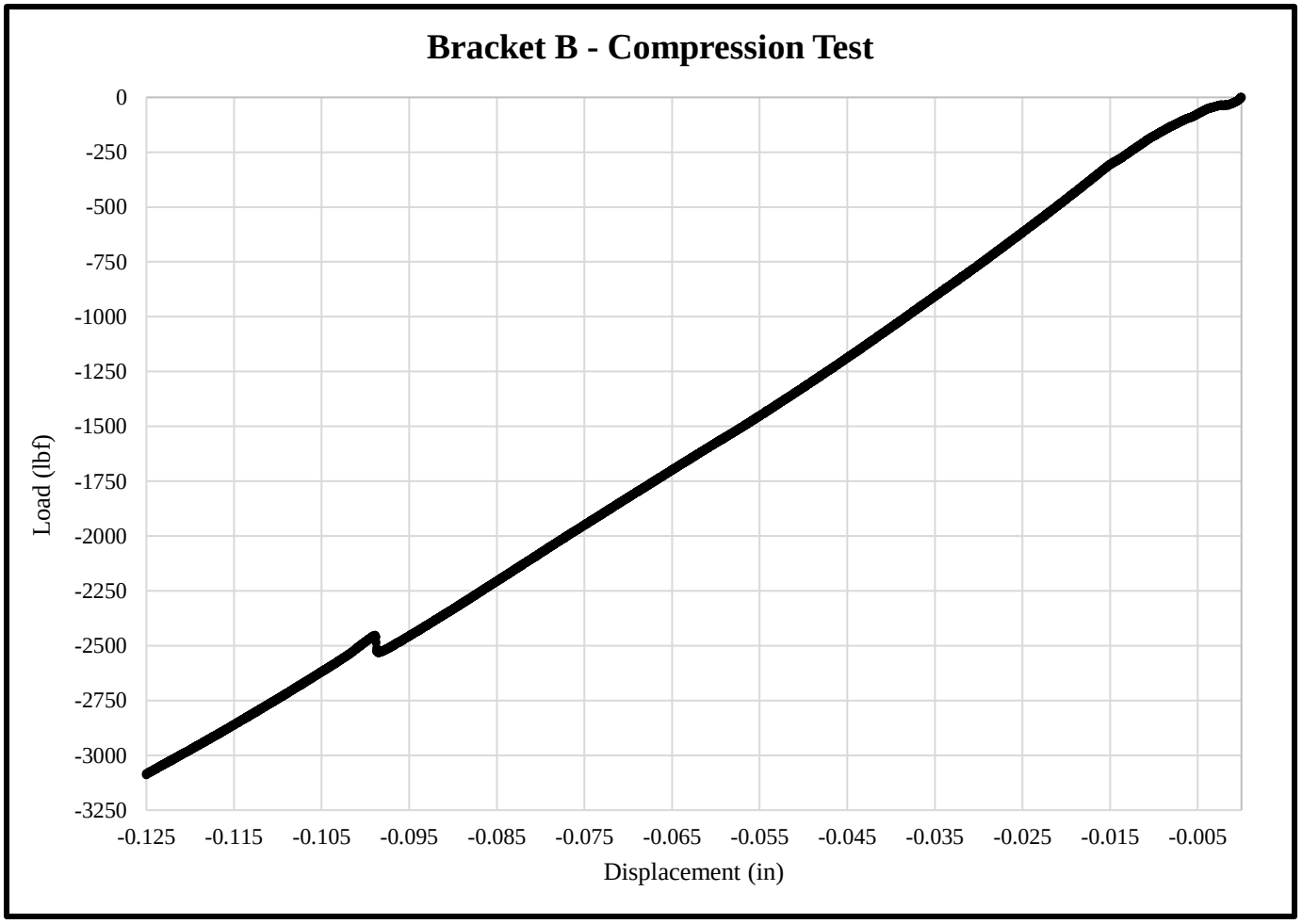

Figure 15: Bracket B - Compression Test data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

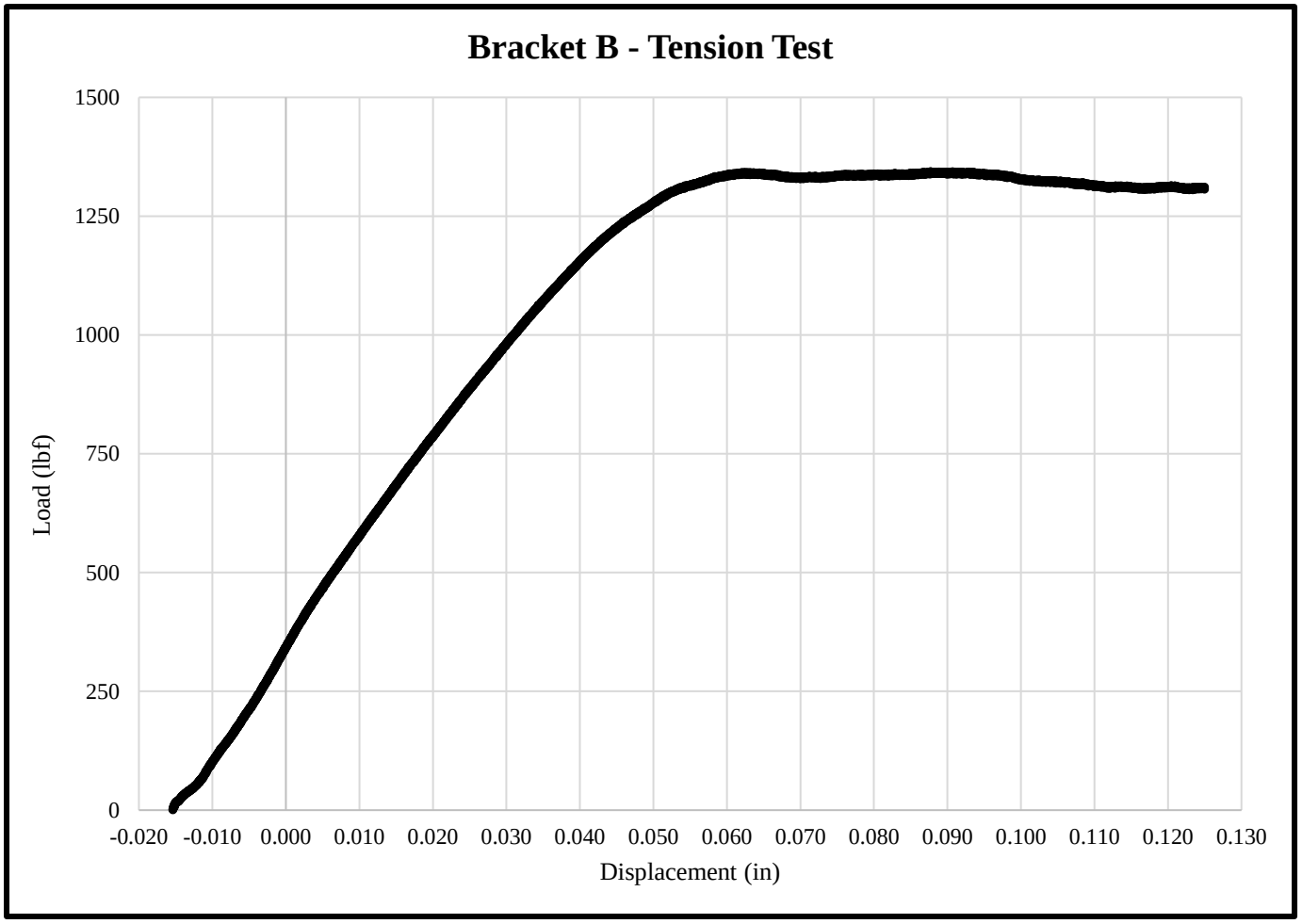

Figure 16: Bracket B - Tension Test data acquisition. Started immediately after Bracket B's Compression Test.

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

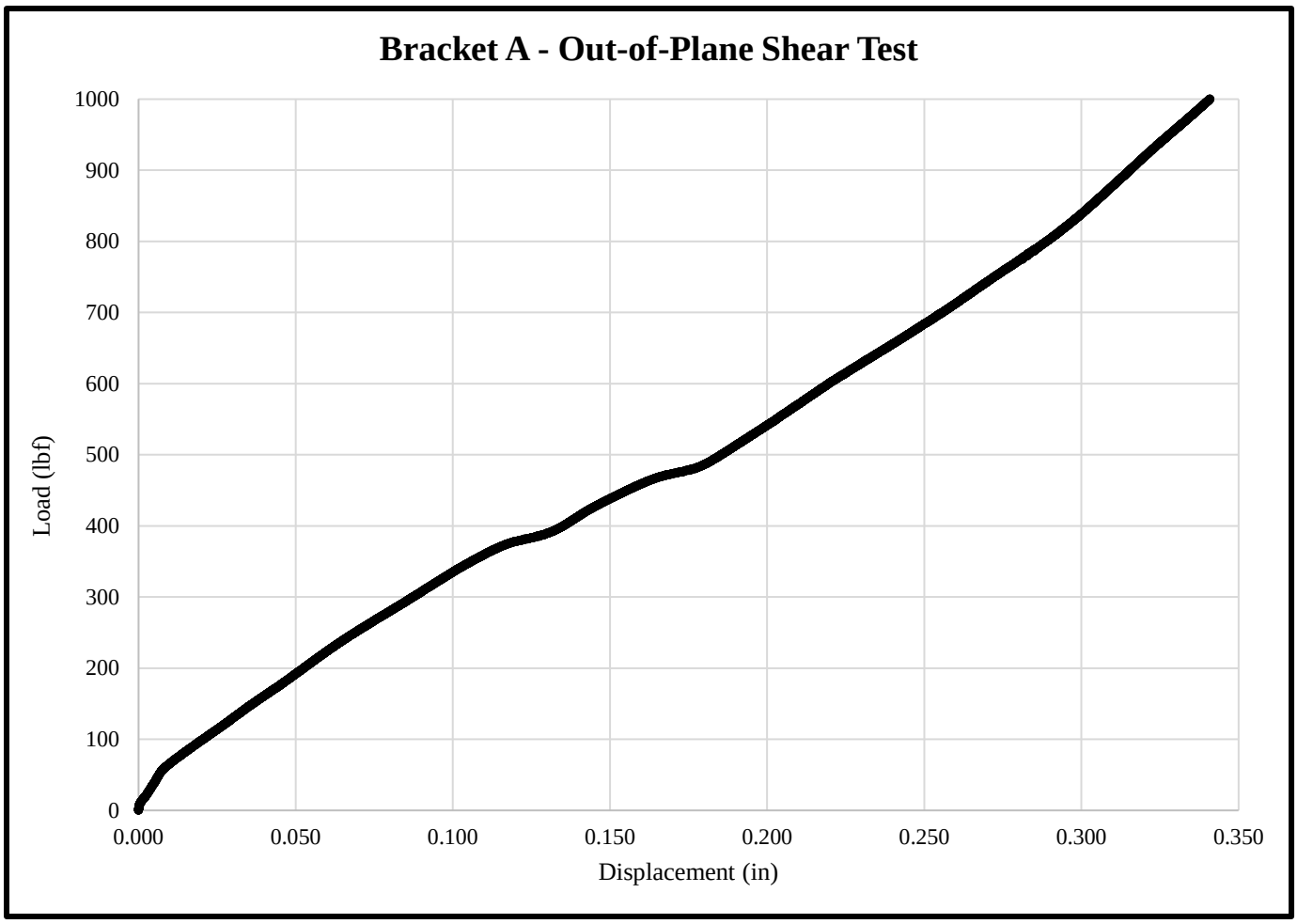

Figure 17: Bracket A - Out-of-Plane Shear data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

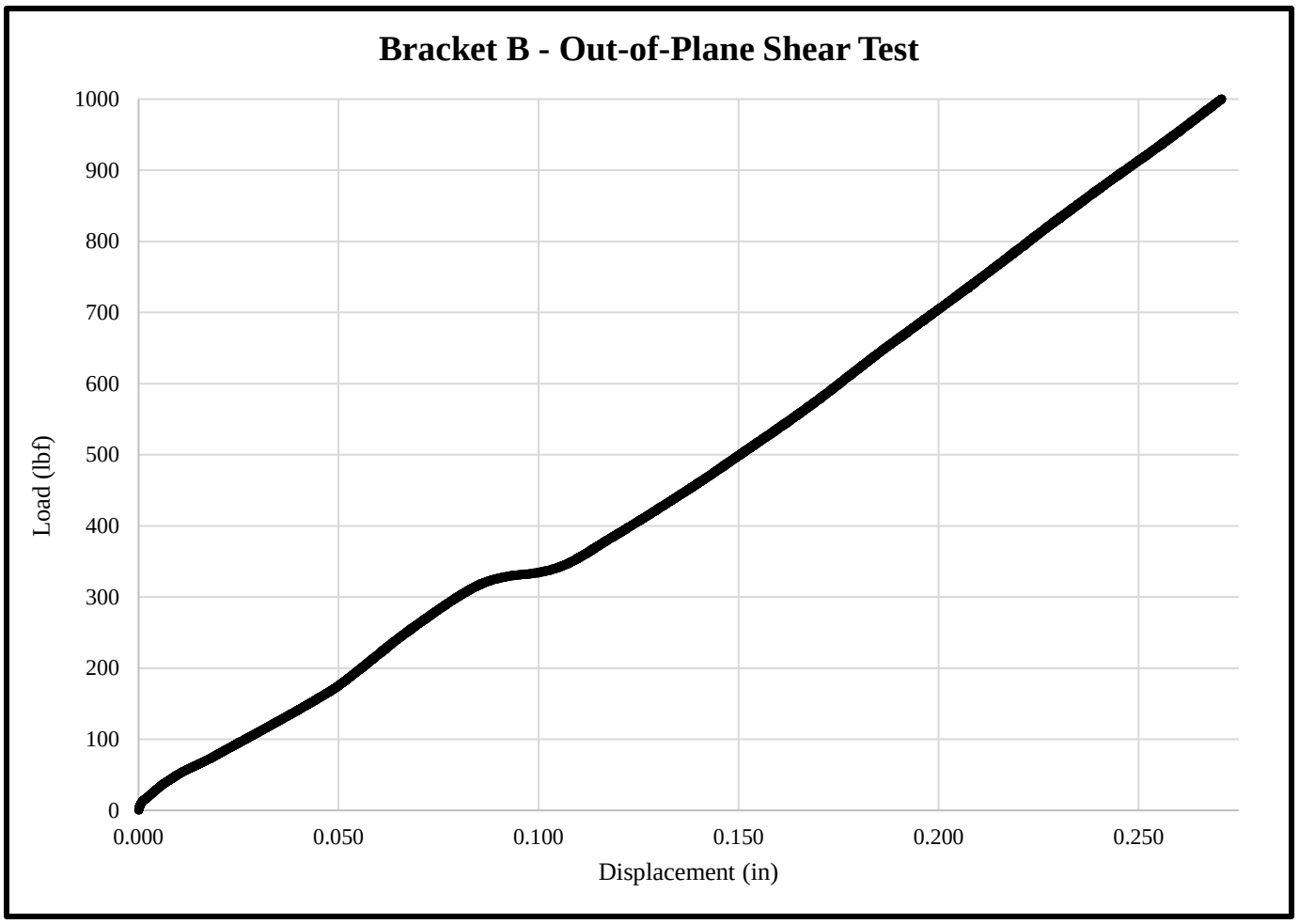

Figure 18: Bracket B - Out-of-Plane Shear data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

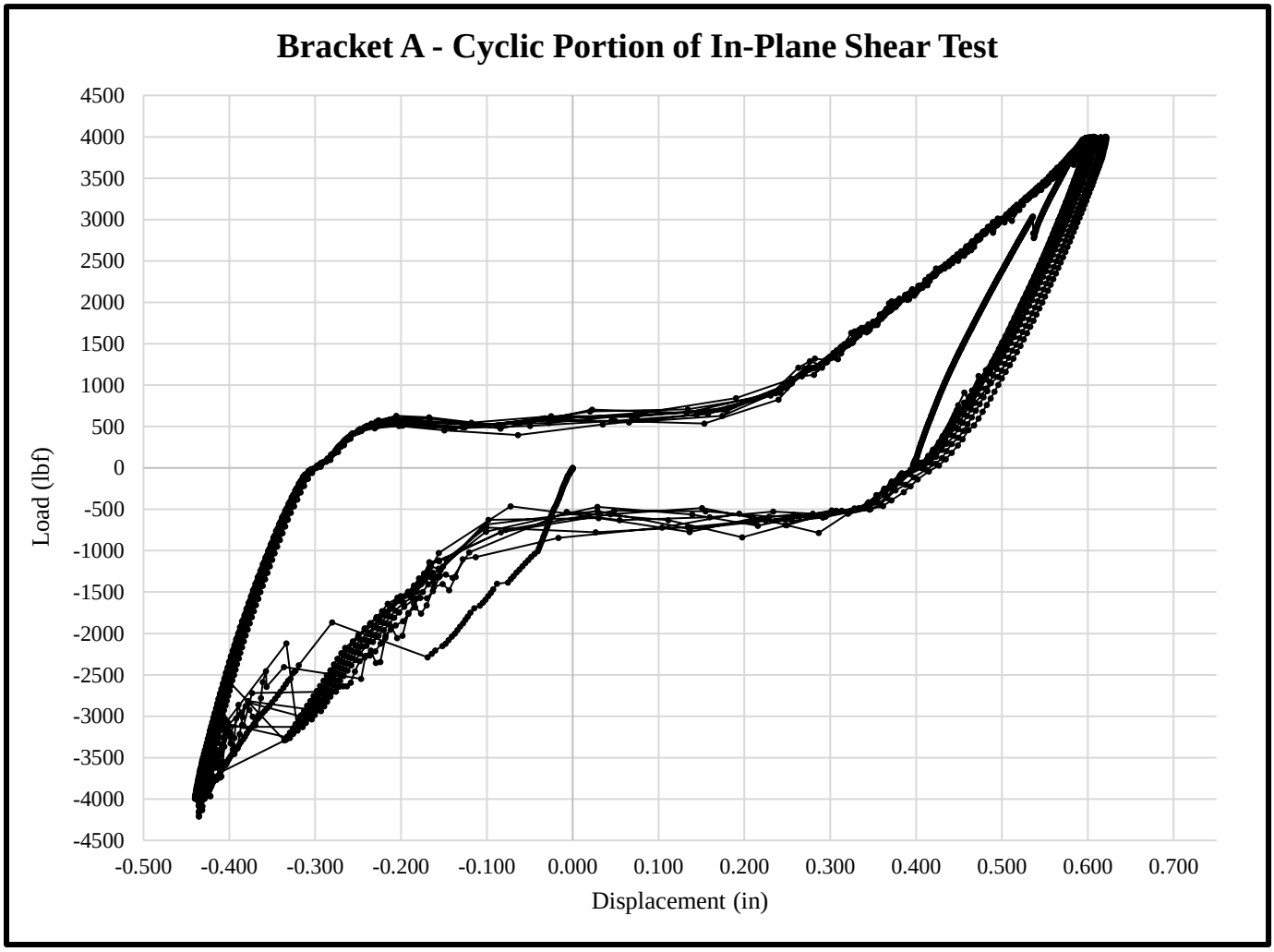

Figure 19: Bracket A – Cyclic In-Plane Shear data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

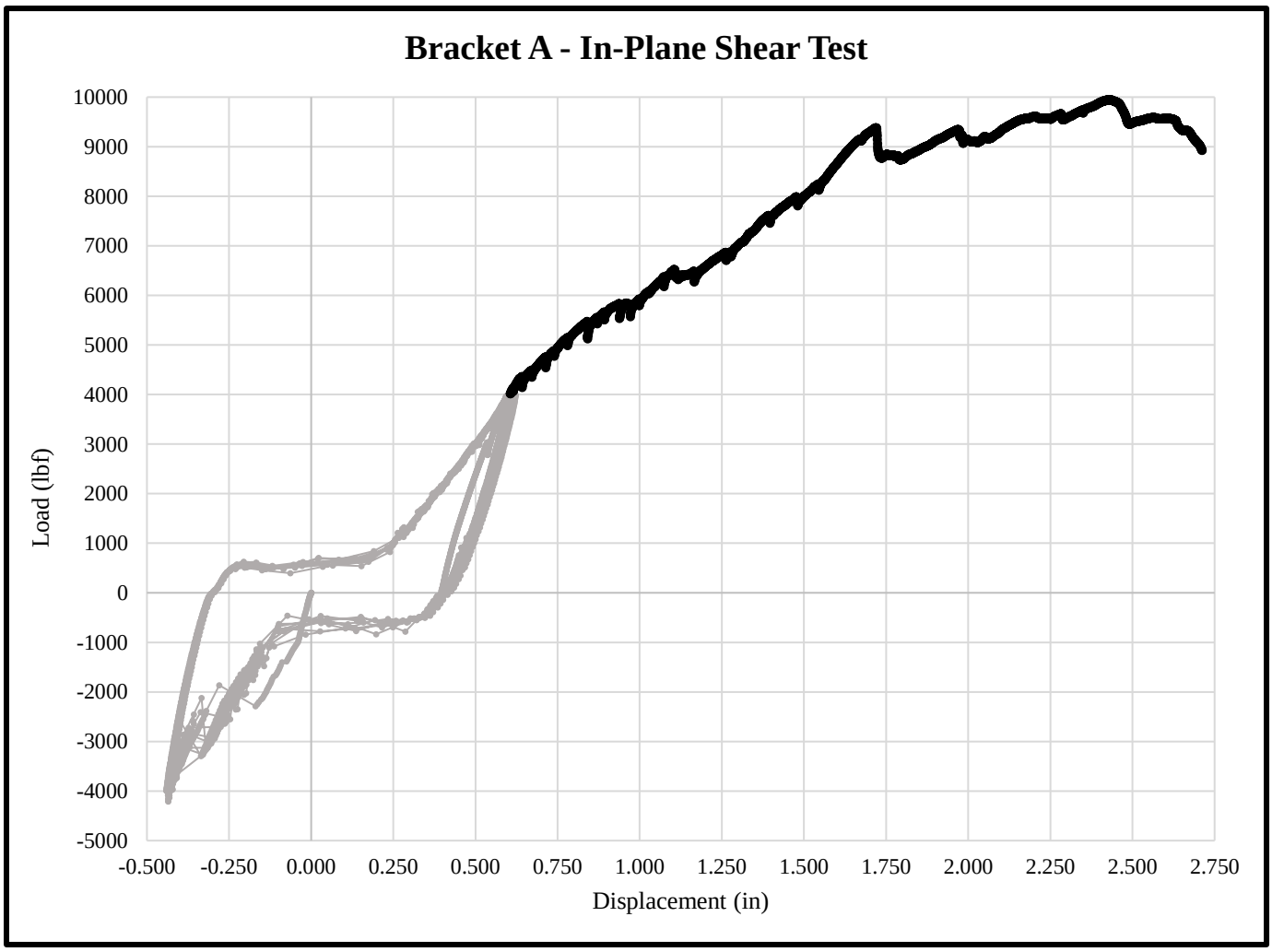

Figure 20: Bracket A – In-Plane Shear data acquisition. Concrete fracturing caused decreases in load when pulling to failure.

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

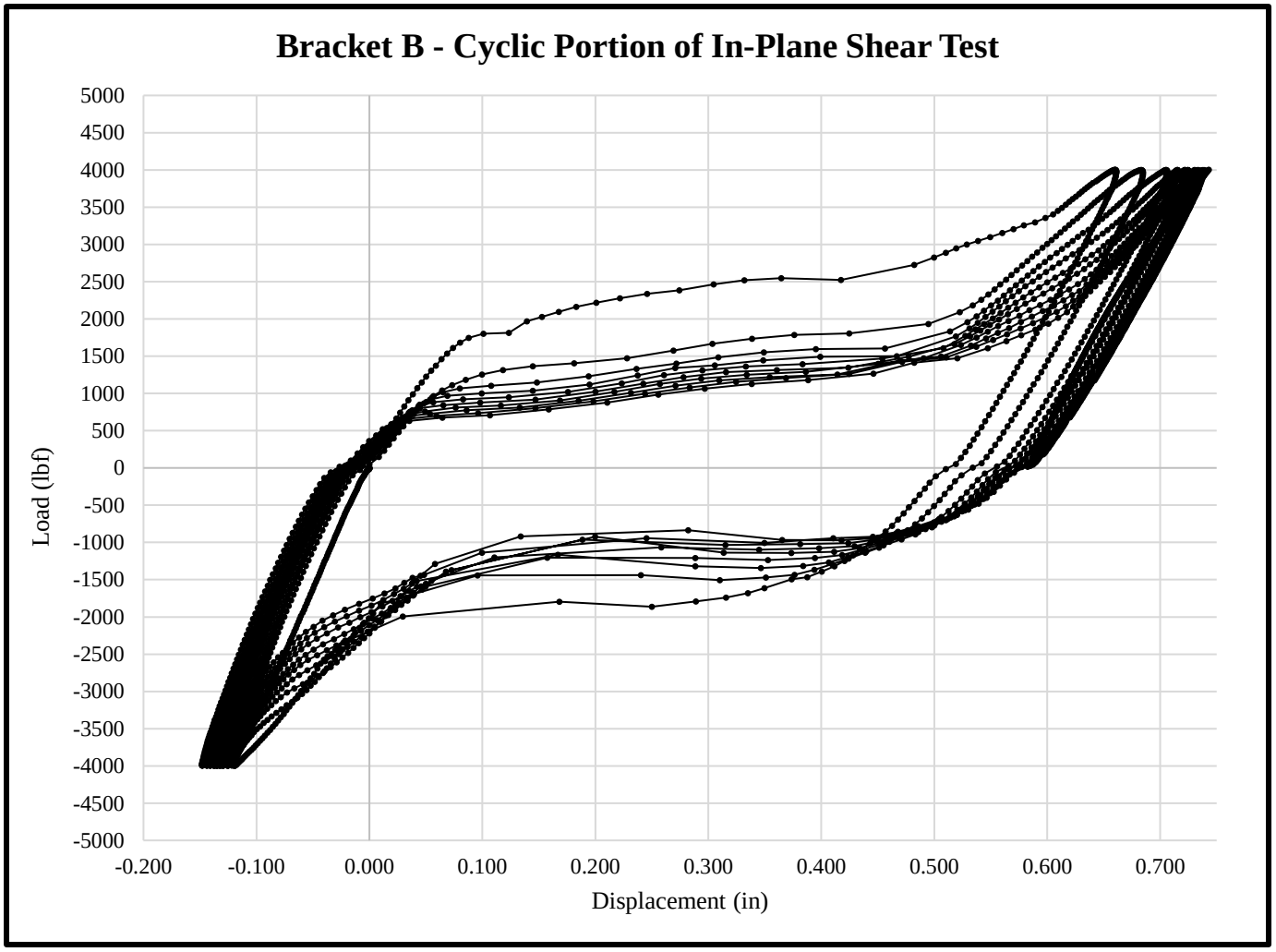

Figure 21: Bracket B – Cyclic In-Plane Shear data acquisition

Revision-R1: *All preliminary bracket results and test protocols were removed per client request. Results of these may be found on ATS Report 411882 dated 3/14/24.*

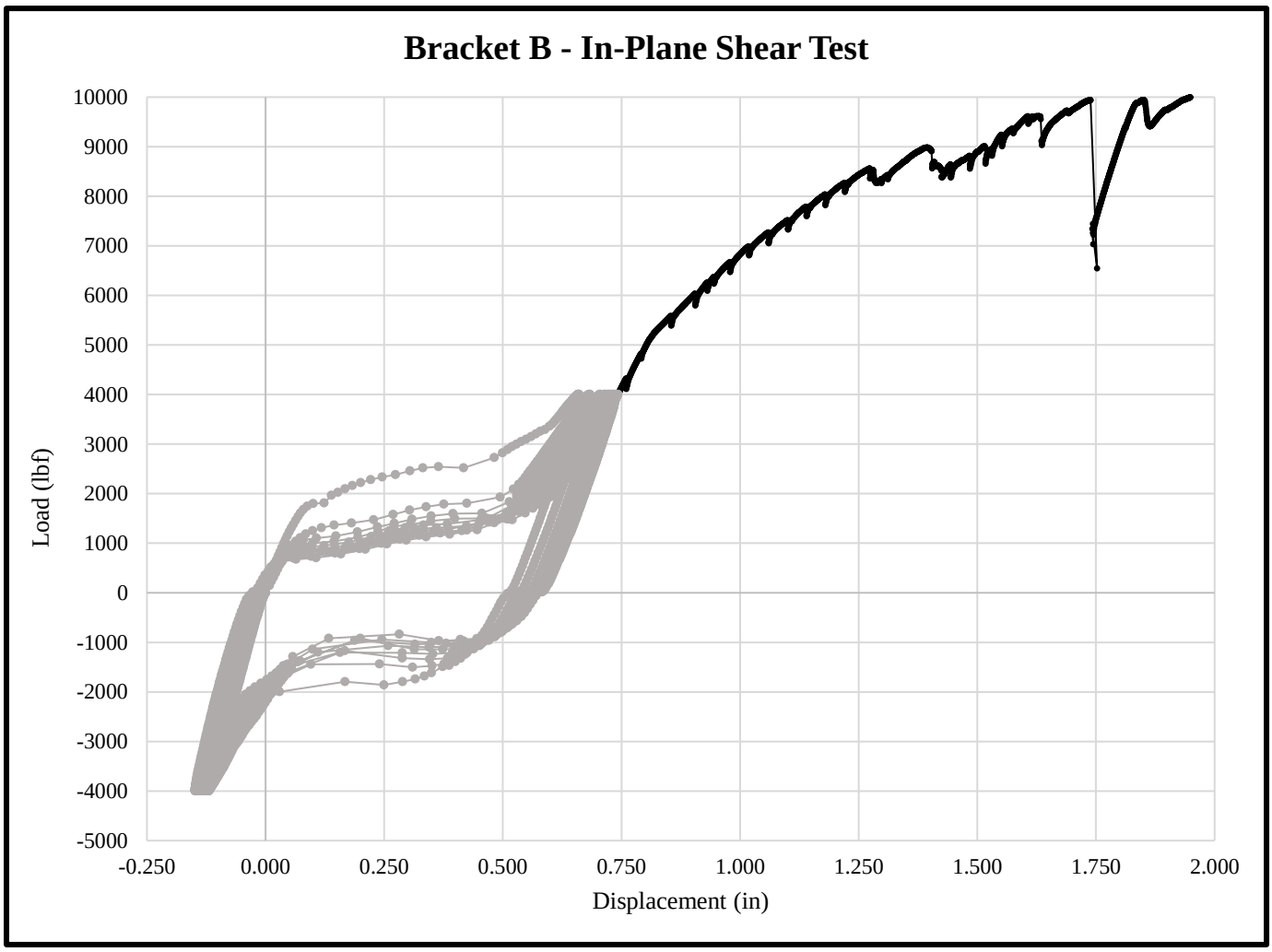

Figure 22: Bracket B - In-Plane Shear data acquisition. 10 cycles of ±4,000 lbf then pull to failure or 10,000 lbf.

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TEST REPORT

APPENDIX

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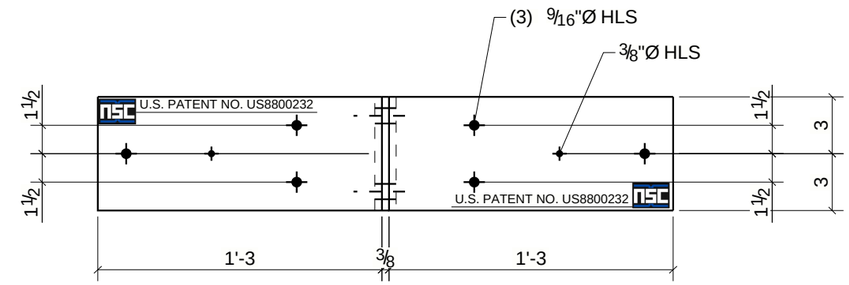

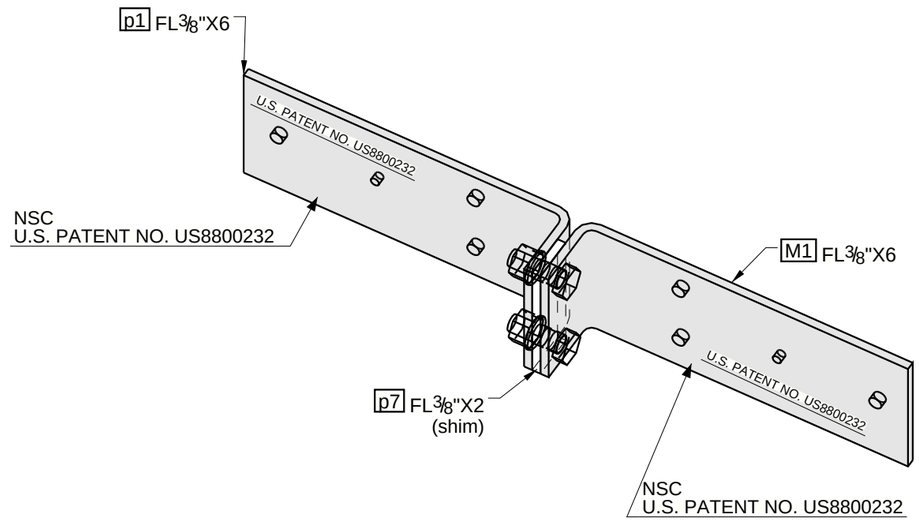

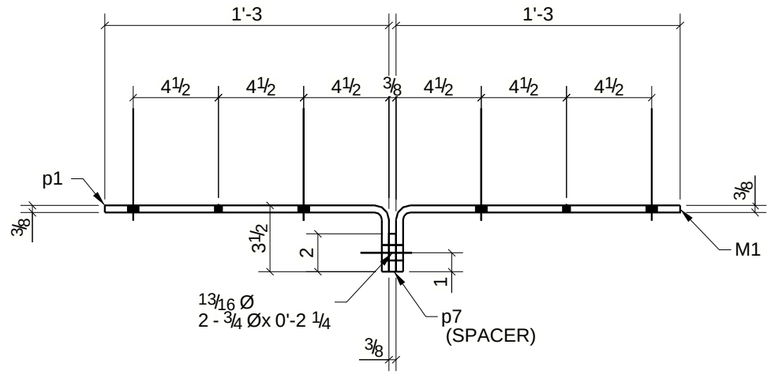

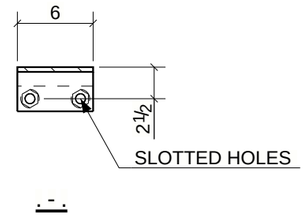

ONE - PLATE - M1

UNDER MOUNTED CONN. ASSEMBLY

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH	REMARKS
M1	1	FL3/8"X6"	1'-5 7/8"	SQ-2 A304 S.S.
p1	1	FL3/8"X6"	1'-5 7/8"	A304 S.S.
p7	1	FL3/8"X2"	0'-6"	A304 S.S.
	2	3/4"Ø A325N BOLT GALV.	0'-2 1/4"	Workshop

REV.	DESCRIPTION	DATE

DESCRIPTION | DATE DRAWN | DRAWN BY | CHECKED BY

NSC INDUSTRIAL CONNECTCO
105 BARCLAY ST
NEW HAVEN ,CT 06519
WEB SITE
https://nscclips.com/

CONTRACTOR		
PROJECT NAME	LOCATION	
DETAILING CO.	ENGINEER	
CHECKED BY :	REF. DRG.	
JOB No.	DRG No. M1	REV.