

TEST REPORT

Report No.: D1817.01-109-44

Rendered to:

ARMSTRONG WORLD INDUSTRIES, INC.
Lancaster, Pennsylvania

PRODUCT TYPE: Ceiling System (Prelude)

SERIES/MODEL: Torsion Spring

SPECIFICATION: UL 580, Underwriters Laboratories, Inc.,
Standard for Safety, Tests for Uplift Resistance of Roof Assemblies

Test Date:	10/01/13
Through:	10/03/13
Report Date:	01/10/14
Test Record Retention Date:	10/03/17

1.0 Report Issued To: Armstrong World Industries, Inc.
2500 Columbia Avenue
P.O. Box 3237
Lancaster, Pennsylvania 17604-3237

2.0 Test Laboratory: Architectural Testing, Inc.
130 Derry Court
York, Pennsylvania 17406-8405
717-764-7700

3.0 Project Summary:

3.1 Product Type: Ceiling System (Prelude)

3.2 Series/Model: Torsion Spring

3.3 Compliance Statement: Results obtained are tested values and were secured by using the designated test method(s). The test specimens were tested in accordance with UL 580. Test Specimen #1 achieved an ultimate test load of -120.0 psf and Test Specimen #2 passed Class 30.

3.4 Test Dates: 10/01/2013 – 10/03/2013

3.5 Test Location: Architectural Testing, Inc. test facility in York, Pennsylvania.

3.6 Test Sample Source: The test specimen was provided by the client. Representative samples of the test specimen(s) will be retained by Architectural Testing for a minimum of four years from the test completion date.

3.7 Test Specimen Installation: The test specimen was installed by representatives from Armstrong World Industries, Inc.

3.8 Drawing Reference: The test specimen drawings have been reviewed by Architectural Testing and are representative of the test specimen(s) reported herein. Test specimen construction was verified by Architectural Testing per the drawings located in Appendix E. Any deviations are documented herein or on the drawings.

3.9 List of Official Observers:

<u>Name</u>	<u>Company</u>
Nathan Canfijn	Armstrong World Industries, Inc.
Michael D. Stremmel, P.E.	Architectural Testing, Inc.
Eric M. Brennan	Architectural Testing, Inc.

4.0 Test Specification(s):

UL 580, Underwriters Laboratories, Inc., *Standard for Safety, Tests for Uplift Resistance of Roof Assemblies*, (Fifth Edition November 2, 2006, revised through July 9, 2009)

The purpose of this test is to evaluate the comparative resistance of roof assemblies to positive and negative pressures. This test simulates the effects of wind gusts by use of oscillating exterior pressure and constant interior pressures.

5.0 Test Specimen Description:

5.1 Product Sizes:

Overall Area: 100.0 ft ² (9.3 m ²)	Width		Length	
	inches	millimeters	inches	millimeters
Overall size	120	3048	120	3048
Full panel size (Specimen No. 1)	24	610	72	1829
Full panel size (Specimen No. 2)	30	762	60	1524

5.2 Test Deck Construction: The test chamber was constructed of steel C-channel that measured 10' long. The C-channels were stacked and welded to form one side of a four sided chamber that measured 60" deep. Five W6 x 31 steel "I" beams were flush at the top of the chamber and equally spaced, welded at each end to the chamber. 2x6 Spruce-Pine-Fir wood was secured to the underside of the "I" beams with #12 x 2-1/2" long self-drilling TEK screws, spaced 18" on center. The lumber was attached to the beams to facilitate securing one end of the compression post. The sides of the chamber utilized 2x6 Spruce-Pine-Fir wood, flush with the bottom of the chamber, secured with #12 x 2-1/2" long self-drilling TEK screws, spaced 18" on center. A bead of silicone was located on the top side of the 2x6, between the steel test chamber and the 2x6 wood.

5.0 Test Specimen Description: (Continued)

5.3 Roof System

Test Specimen No. 1:

Components	Details	Attachment Method
Perimeter C-channel	0.125" Aluminum	Secured with #8 x 1-1/4" pan-truss head screws through the channel and into the perimeter lumber
Armstrong Prelude Torsion Spring main beams	The main beam members were constructed from galvanized steel and slotted 6" on center	The main beams were set on top of the perimeter C-channel. The beams were spaced 24" on center and secured with #8 x 1/2" pancake head screws through the top flange of the perimeter channel and into the underside of the main beams.
Armstrong Prelude Torsion Spring cross tees	The 24" long cross tee members were constructed from galvanized steel	The cross tees utilized tabs at the ends which were inserted into the main beam slots. The cross tees intersected the main beams at 90° at every panel intersection and were secured with #8 x 1/2" long pancake head screws through the top of the perimeter C-channel and into the underside cross tees.
Compression posts	The posts were constructed from 3-5/8" wide, 20 ga steel	The posts were located on the main beams 24" on center and secured to the 2x6 overhead wood beams with two #8 x 1-1/4" long pancake head screws. The posts were secured to the main beams with BACG90A clips. The clips were secured to the main beams with #10-16 x 1-1/4" long hex-head screws
Torsion Spring panels	The Torsion Spring panels were constructed from 0.050" thick aluminum	The 24" x 72" panels utilized retaining springs on opposing sides of the panel which engaged slots on the main beams in order to secure the panels to the ceiling. Cut panels at the perimeter utilized a spreader channel that was secured to the perimeter channel with one #8 x 1-1/4" long pancake head screw through the vertical wall of the channel and into the perimeter channel.

5.0 Test Specimen Description: (Continued)

5.4 Roof System

Test Specimen No. 2:

Components	Details	Attachment Method
Perimeter C-channel	0.125" Aluminum	Secured with #8 x 1-1/4" pan-truss head screws through the channel and into the perimeter lumber
Armstrong Prelude Torsion Spring main beams	The main beam members were constructed from galvanized steel and slotted 6" on center	The main beams were set on top of the perimeter C-channel. The beams were spaced 30" on center and secured with #8 x 1/2" pancake head screws through the top flange of the perimeter channel and into the underside of the main beams.
Armstrong Prelude Torsion Spring cross tees	The 30" long cross tee members were constructed from galvanized steel	The cross tees utilized tabs at the ends which were inserted into the main beam slots. The cross tees intersected the main beams at 90° at every panel intersection and were secured with #8 x 1/2" long pancake head screws through the top of the perimeter C-channel and into the underside cross tees.
Compression posts	The posts were constructed from 3-5/8" wide, 20 ga steel	The posts were located on the main beams 24" on center and secured to the 2x6 overhead wood beams with two #8 x 1-1/4" long pancake head screws. The posts were secured to the main beams with BACG90A clips. The clips were secured to the main beams with #10-16 x 1-1/4" long hex-head screws
Torsion Spring panels	The Torsion Spring panels were constructed from 0.050" thick aluminum	The 30" x 60" panels utilized retaining springs on opposing sides of the panel which engaged slots on the main beams in order to secure the panels to the ceiling. Cut panels at the perimeter utilized a spreader channel that was secured to the perimeter channel with one #8 x 1-1/4" long pancake head screw through the vertical wall of the channel and into the perimeter channel.

6.0 Test Results: Two assemblies were tested per UL 580. The following summarizes observations made during the test at each class rating.

Test Specimen No. 1:

Test Class	Test Phase	Results
Class 30 Phases 1-5	No visible damage to the system Reference Table #1 for deflection measurements	PASSED
Class 60 Phases 1-5	No visible damage to the system Reference Table #2 for deflection measurements	PASSED
Class 90 Phases 1-5	No visible damage to the system Reference Table #3 for deflection measurements	PASSED
Supplemental Loads -120.0 psf	No visible damage to the system Reference Table #4 for deflection measurements	PASSED
Supplemental Loads -135.0 psf	Perimeter partial panel released from perimeter track.	FAILED

Test Specimen No. 2:

Test Class	Test Phase	Results
Class 30 Phases 1-5	No visible damage to the system Reference Table #5 for deflection measurements	PASSED
Class 60 Phases 1-2	No visible damage to the system Reference Table #6 for deflection measurements	PASSED
Class 60 Phases 3	Main beam buckled between posts.	FAILED

Notes:

- Reference Chart #1 located in Appendix A for test pressures and load durations.
- Reference Sketch #1 in Appendix B for location of deflection measurement devices.
- Deflection measurements are included in Table #1 through Table #6 in Appendix C of this test report.
- Reference Appendix D for Photograph for mode of failure.

General Test Note: A loose fitting, pleated 4-mil plastic film was utilized to assist in obtaining uniform pressure on the ceiling system. The plastic film was located under the torsion spring panels to facilitate testing of the ceiling system. In our opinion, this did not influence test results.

The service life of this report will expire on the stated Test Record Retention End Date, at which time such materials as drawings, data sheets, samples of test specimens, copies of this report, and any other pertinent project documentation, shall be discarded without notice.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimen(s) tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.

For ARCHITECTURAL TESTING, Inc.



Digitally Signed by: Eric Brennan

Eric M. Brennan
Project Manager



Digitally Signed by: Michael D. Stremmel

Michael D. Stremmel, P.E.
Senior Project Engineer

EMB:asm

Attachments (pages): This report is complete only when all attachments listed are included.

- Appendix-A: Chart (1)
- Appendix-B: Sketches (2)
- Appendix-C: Tables (2)
- Appendix-D: Photographs (2)
- Appendix-E: Drawings (2)

Appendix A

Chart #1

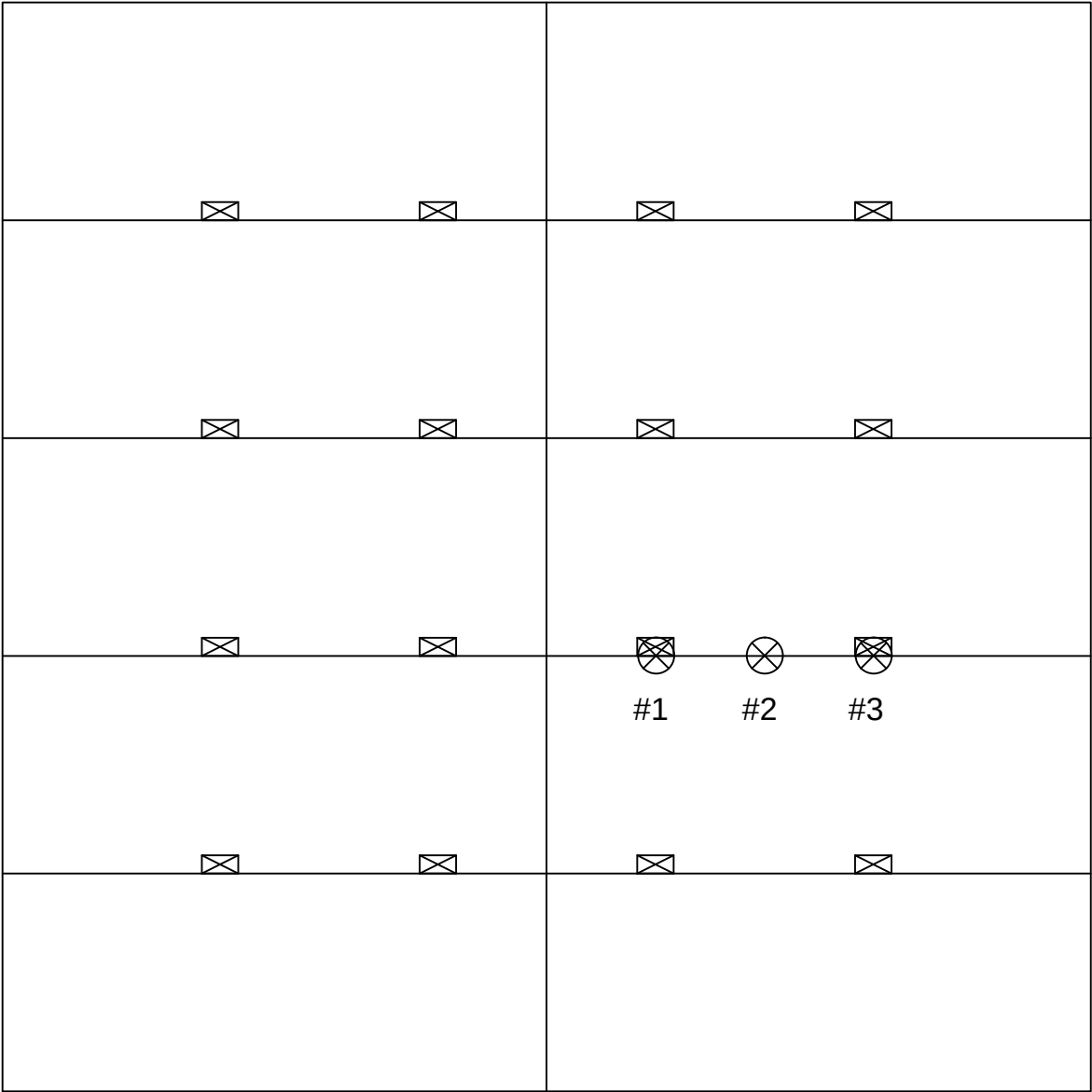
UL 580 Load Table Test Pressures

		Negative Pressure		Positive Pressure	
Test Phase	Time Duration (minutes)	Pounds Per Square Foot psf (kPa)	Inches (mm) of Water	Pounds Per Square Foot psf (kPa)	Inches (mm) of Water
Class 30					
1	5	16.2 (0.79)	3.1 (79)	0.0 (0.00)	0.0 (0)
2	5	16.2 (0.79)	3.1 (79)	13.8 (0.66)	2.7 (69)
3	60	8.1 - 27.7 (0.39 - 1.33)	1.5 - 5.3 (38 - 135)	13.8 (0.66)	2.7 (69)
4	5	24.2 (1.16)	4.7 (119)	0.0 (0.00)	0.0 (0)
5	5	24.2 (1.16)	4.7 (119)	20.8 (1.00)	4.0 (102)
Class 60					
1	5	32.3 (1.55)	6.2 (157)	0.0 (0.00)	0.0 (0)
2	5	32.3 (1.55)	6.2 (157)	27.7 (1.33)	5.3 (135)
3	60	16.2 - 55.4 (0.79 - 2.66)	3.1 - 10.7 (79 - 272)	27.7 (1.33)	5.3 (135)
4	5	40.4 (1.94)	7.8 (198)	0.0 (0.00)	0.0 (0)
5	5	40.4 (1.94)	7.8 (198)	34.6 (1.66)	6.7 (170)
Class 90 (maximum combined uplift pressure of 105 psf)					
1	5	48.5 (2.33)	9.3 (236)	0.0 (0.00)	0.0 (0)
2	5	48.5 (2.33)	9.3 (236)	41.5 (1.99)	8.0 (203)
3	60	24.2 - 48.5 (1.16 - 2.33)	4.7 - 9.3 (119 - 236)	41.5 (1.99)	8.0 (203)
4	5	56.5 (2.71)	10.9 (277)	0.0 (0.00)	0.0 (0)
5	5	56.5 (2.71)	10.9 (277)	48.5 (2.33)	9.3 (236)

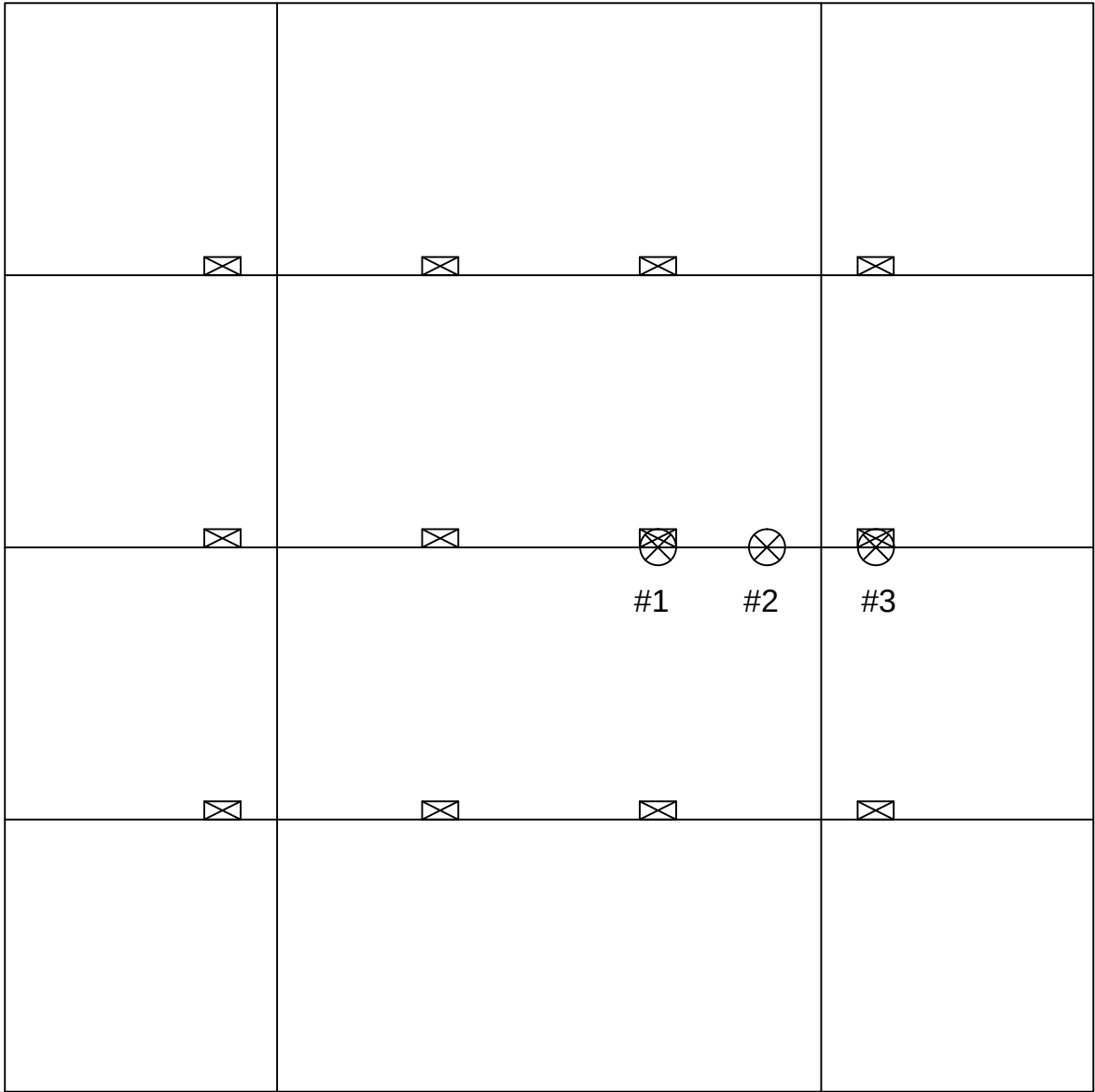
Appendix B

Sketches

REV	DATE	DESCRIPTION	BY



REV	DATE	DESCRIPTION	BY



Appendix C

Test Specimen #1 Tables

Table #1			
Class 30 Deflection Measurements (inches)			
Phase	#1	#2	#3
1	0.03	0.03	0.03
2	0.04	0.04	0.06
3 Minimum	0.03	0.04	0.05
3 Maximum	0.04	0.04	0.06
4	0.07	0.08	0.09
5	0.12	0.11	0.08
Final (0.0 psf)	0.04	0.05	0.04
Table #2			
Class 60 Deflection Measurements (inches)			
Phase	#1	#2	#3
1	0.05	0.05	0.05
2	0.10	0.13	0.14
3 Minimum	0.12	0.13	0.16
3 Maximum	0.16	0.16	0.18
4	0.08	0.09	0.10
5	0.18	0.21	0.23
Final (0.0 psf)	0.05	0.06	0.06
Table #3			
Class 90 Deflection Measurements (inches)			
Phase	#1	#2	#3
1	0.07	0.11	0.14
2	0.17	0.19	0.23
3 Minimum	0.13	0.17	0.19
3 Maximum	0.19	0.24	0.22
4	0.14	0.19	0.20
5	0.21	0.20	0.25
Final (0.0 psf)	0.07	0.09	0.09

Test Specimen #1 Tables
(Continued)

Table #4					
Supplemental Deflection Measurements (inches)					
Vacuum (psf)	Uplift (psf)	Load (psf)	Indicator		
			#1	#2	#3
-56.5	-63.5	-120	0.20	0.17	0.21
-56.5	-78.5	-135	Fail		

Test Specimen #2 Tables

Table #5			
Class 30 Deflection Measurements (inches)			
Phase	#1	#2	#3
1	0.05	0.07	0.07
2	0.10	0.09	0.11
3 Minimum	0.11	0.12	0.13
3 Maximum	0.22	0.20	0.19
4	0.09	0.08	0.09
5	0.24	0.26	0.23
Final (0.0 psf)	0.11	0.10	0.10
Table #6			
Class 60 Deflection Measurements (inches)			
Phase	#1	#2	#3
1	0.11	0.13	0.15
2	0.25	0.19	0.20
3 Minimum	Fail		

Appendix D

Photographs



Photo No. 1
Perimeter, Main, and Tee Detail

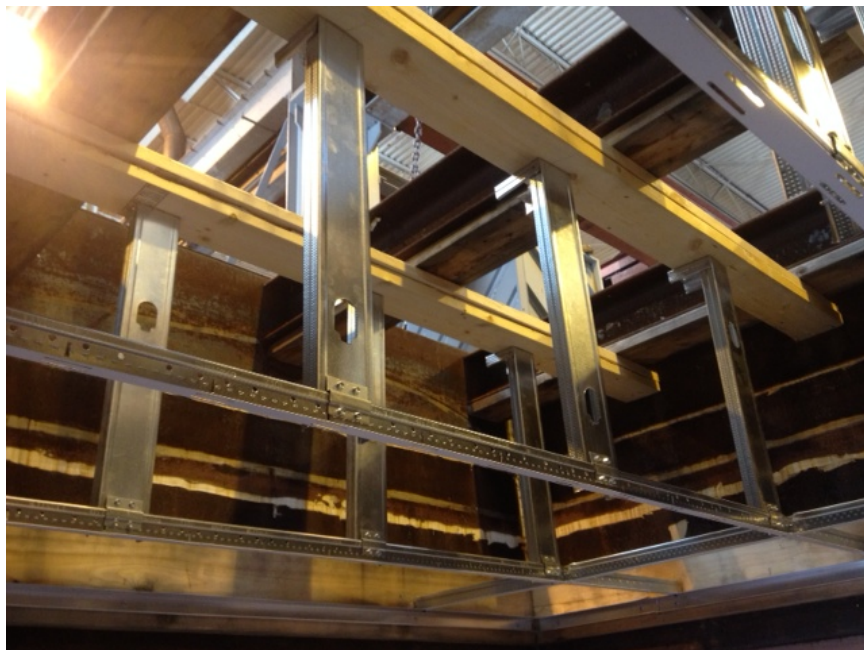


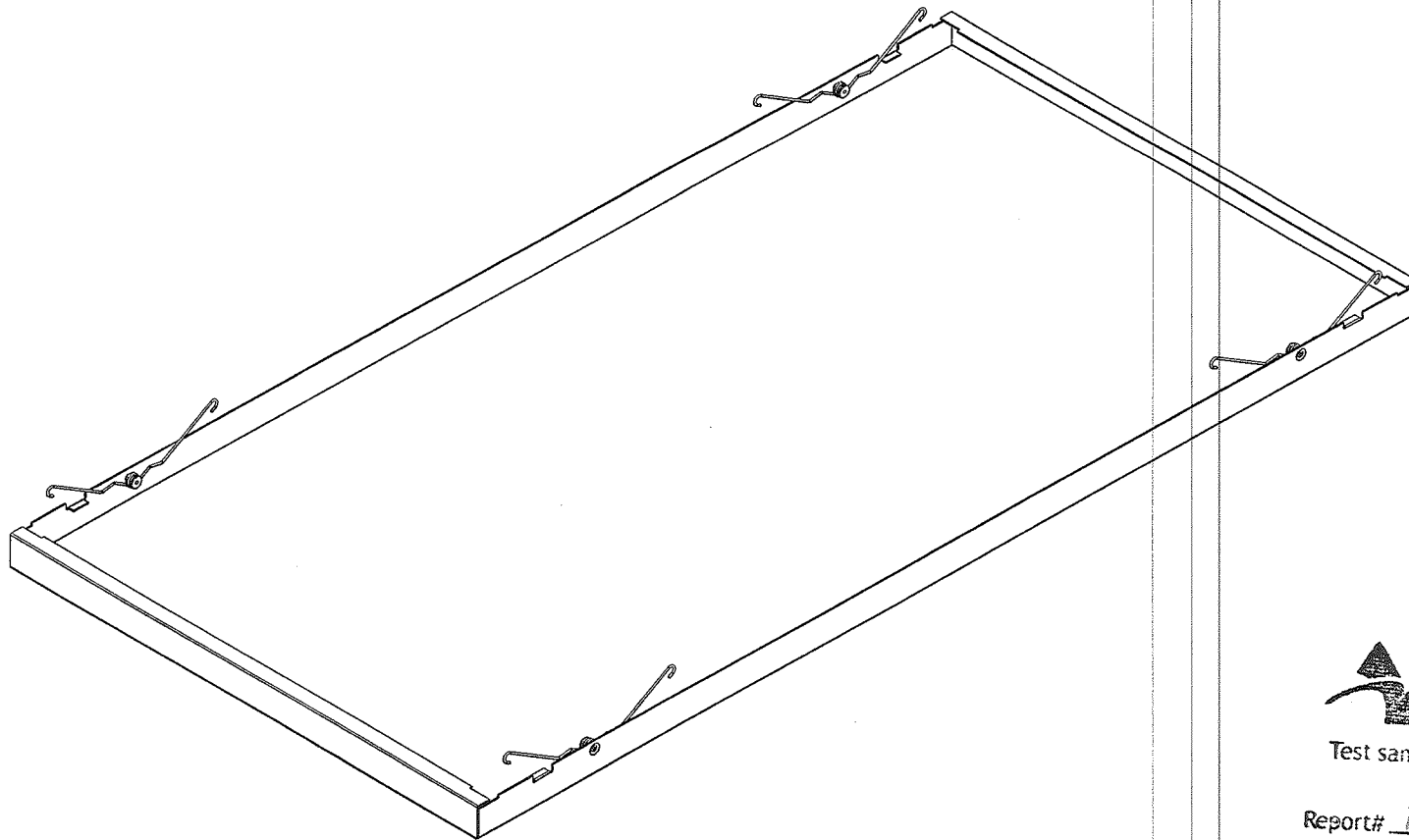
Photo No. 2
Post Detail



Photo No. 3
Specimen No. 1 Failure Method

Appendix E

Drawings



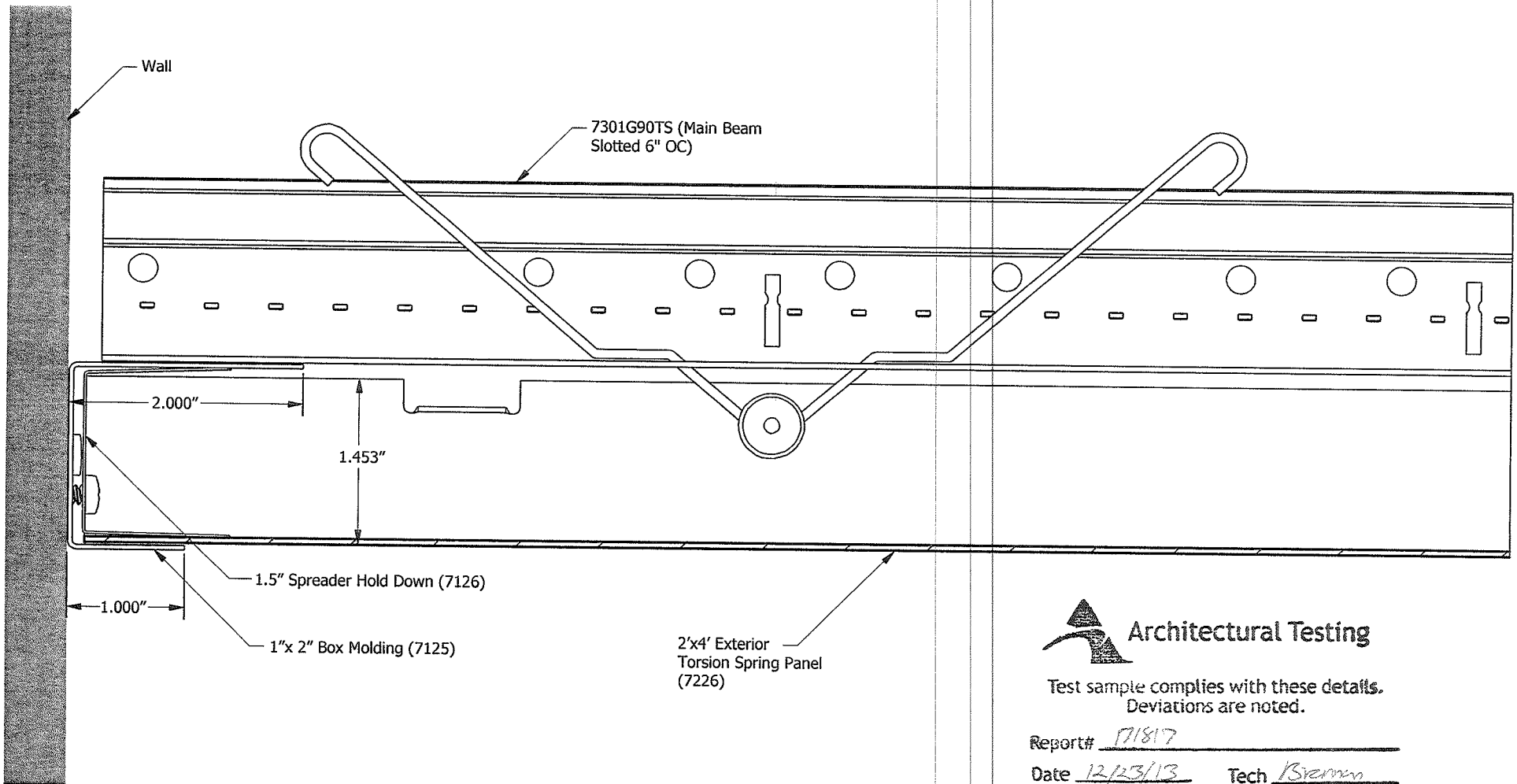
Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report# 071817

Date 12/23/13

Tech Brammer



Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report# 171817

Date 12/23/13 Tech K. Sieman