

TEST REPORT ON
CENTRAL STATES MANUFACTURING, INC.'S
R-LOC PANELS
(26 GA., 80 KSI, 36" WIDE)
AT 3' 6" & 1' 0" PANEL SPANS
IN ACCORDANCE WITH
ASTM E1592-05(2015)

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TESTING DATE: July 26, 27 & August 2, 2017
REPORTING DATE: August 7, 2017

ENCON® Project C2154-1



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TEST SUMMARY

1.1 SUMMARY

Tests were conducted on Central States Manufacturing's R-Loc (1.25" high rib, 36" wide, 26 Ga., 80 ksi) panels at ENCON® Technology, Inc.'s Test Facility, Tulsa, Oklahoma. These tests meet the provisions of ASTM E1592-05(2015). The tests are listed below according to their configurations and date tested.

Test #1: Uplift load test at panel span of 3' 6" o.c. The panels were fastened to 7/16" thick OSB sheathing with #10 x1.5" long wood screws with washers spaced at 12" o.c. across panel width. Tested on July 26, 2017.

Test #2: Uplift load test at panel span of 1' 0" o.c. The panels were fastened to 7/16" thick OSB sheathing with #10 x1.5" long wood screws with washers spaced at 12" o.c. across panel width. Tested on July 27, 2017.

Test #3: Uplift load test at panel span of 1' 0" o.c. The panels were fastened to 15/32" thick plywood sheathing with #10 x1.5" long wood screws with washers spaced at 12" o.c. across panel width. Tested on August 2, 2017.

The sidelap fastener spacing was 24" o.c. for all tests. The above defined tests were witnessed by Bala Sockalingam, Ph.D., P.E., of ENCON Technology.

1.2 PANEL SYSTEM DESCRIPTION

R-Loc panels were 26 ga., 1.25" high and 36" wide, 80 ksi through fastened panels. Each panel consisted of 4 ribs spaced at 12" o.c. as shown on Page 3.

For Test #1 and #2, the panels were fastened to 7/16" thick OSB sheathing with #10 x1.5" long Kwikseal MB Woodbinder screws with washers spaced at 12" o.c. across the panel width at the interior and at 7"-5"-7" o.c. across the panel width at panel ends. The fastener spacing along length was 3' 6" o.c. for Test #1 and 1' 0" o.c. for Test #2.

For Test #3, the panels were fastened to 15/32" thick plywood sheathing with #10 x1.5" long Kwikseal MB Woodbinder screws with washers spaced at 12" o.c. across the panel width at the interior and at 7"-5"-7" o.c. across the panel width at panel ends. The fastener spacing along length was 1' 0" o.c.

The sidelap fasteners were 1/4"-14 x 7/8" long self-drilling lap screws (Sealtite Building Fasteners) and were spaced at 24" o.c. for all tests. The panel profile and installation details are shown Page 3.

The OSB and plywood decks were fastened to rafters with 8d x 2.5" long ring shank nails at 6" o.c. The rafters were spaced at 24" o.c. The decks were covered with one layer of 30 lb. felt. There were gaps in the deck joints to allow the air pressure to be applied on the panels.

TEST SUMMARY

1.3 TEST RESULTS

The panels were loaded to a failure condition and observations made. The failure mode in all tests was panel fastener pullout. The ultimate and design loads for each test are shown on Table 1. Diagrammatic representations of these test setups are illustrated on Pages 22-24.

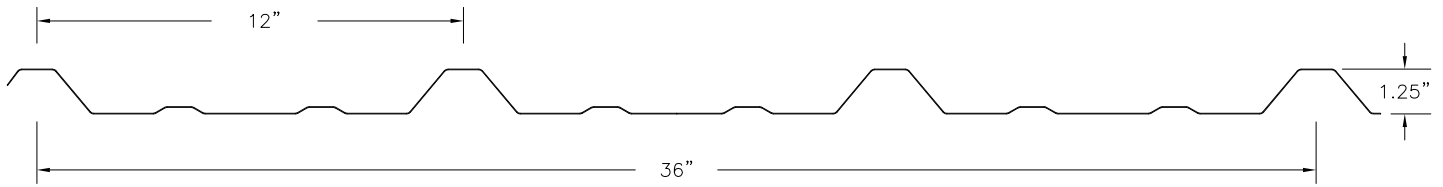
Table 1. Test Results for 26 ga., 36" wide R-Loc Panel

Test	Deck Type	Panel Span	Ultimate Load (psf)	Design Load (psf)
1	7/16" thick OSB	3' 6"	50	25.0
2	7/16" thick OSB	1' 0"	148	74.0
3	15/32" thick Plywood	1' 0"	211	105.5

Notes:

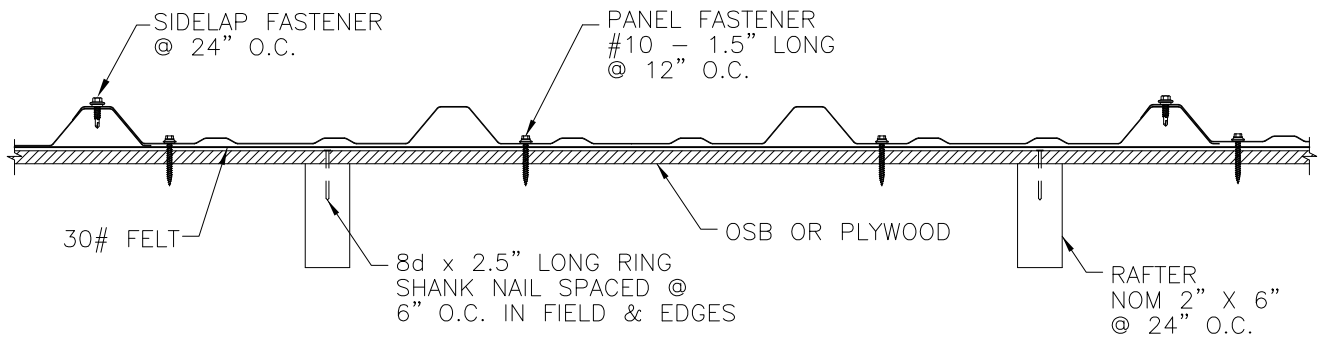
1. The design load is calculated by dividing the ultimate load by the factor of safety of 2.
2. Panels were fastened with #10 x1.5" long Kwikseal MB Woodbinder screws with washers spaced at 12" o.c. across the panel width at the interior and at 7"-5"-7" o.c. across the panel width at panel ends.
3. The sidelap fasteners were 1/4"-14 x 7/8" long self-drilling lap screws and were spaced at 24" o.c. for all tests.

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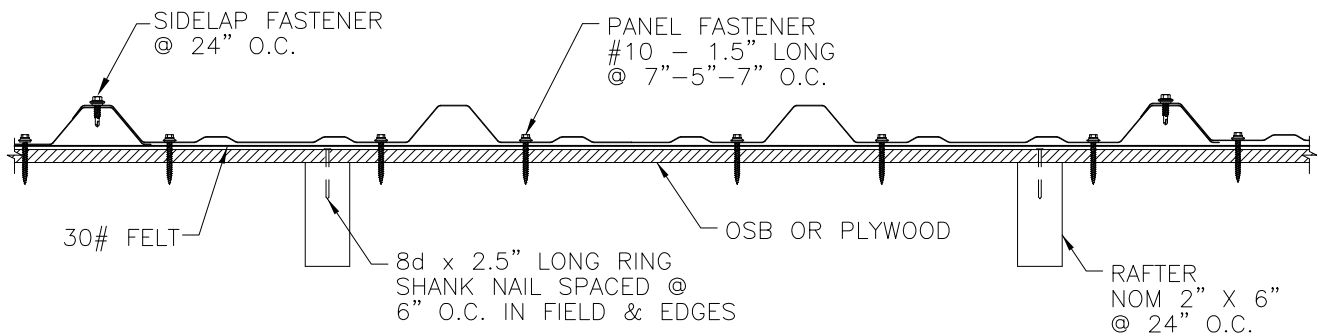


R-LOC PANEL PROFILE

26 Ga., Minimum Yield = 80 KSI



INTERIOR



PANEL ENDS

FASTENING PATTERN

DESCRIPTION OF TEST

2.1 DESCRIPTION OF TEST

Tests were conducted to determine the structural performance of the metal panel under uniform static pressure difference. The test method consisted of the following: (1) sealing the test specimen against one face of a test chamber; (2) supplying air to and exhausting air from the chamber at the rate required to maintain the test pressure difference across the specimen; and (3) observing, measuring, and recording the deflections, deformations, and nature of any failures of principal or critical elements of the panel profile or members of the anchor system. The increments of load application were chosen such that a sufficient number of readings were obtained to determine the load deformation curve of the system.

2.1.1 TEST CHAMBER

The test chamber consisted of a box as shown in the applicable drawings in Section V. It contains one open surface against which the test specimen is installed. Two static pressure taps are located at corners to measure the chamber pressure in such a manner that the readings are not affected by the velocity of the air supply to or from the chamber or other air movement. The air supply openings into the chamber are arranged so that the air does not impinge directly on the test specimen with significant velocity.

2.1.2 AIR SYSTEM

The compressed air supply consists of a number of individual compressor units capable of maintaining a constant air pressure difference for the required test period. A digital manometer is used to measure the test pressure difference with accuracy of 1/10".

2.1.3 DEFLECTION MEASUREMENT

Deflection measurements were taken by means of a level and staffs calibrated to 1/100 of an inch, which were attached to the topside of the specimen. Reading locations are as shown on the drawings in Section V.

2.1.4 TEST PROCEDURE

For the uplift load tests, a nominal air pressure of 5 psf, which was equivalent to six times the dead weight of the specimen, was applied to the test panel for a minimum of 60 seconds and until the panel had stabilized and readings were taken. These readings were considered as bench mark readings and the load corresponding to these readings were considered as "Reference Zero Load".

The air pressure was then increased by load increments as shown on recorded data and held for 60 seconds and until the panel had stabilized and the first set of readings were measured for the test panel. The air pressure was then reduced to zero or no load and then once again to the Reference Zero Load and the bench mark readings were taken.

DESCRIPTION OF TEST

This procedure was repeated several times each time increasing the air pressure by a load increment over the previous load. It was ensured that benchmark readings were taken between each incremental increase in order to keep track of permanent deflections. This load sequence was continued until the panel was subjected to maximum air pressure resulting in its failure.

2.1.5 TEST SPECIMEN

The test specimen was of sufficient size to determine the performance of all typical parts of the panel system excluding support elements such as supports, eave struts, rake angles and similar structural parts supporting the panel system. Conditions of structural support of the panel system were simulated as accurately as possible. The test specimen included the panels and fasteners attachment of the panels to the decks. All of the parts of the test specimen were actual size and material. The overall dimension of the specimen was in excess of 10' x 10'. The panels were supported by deck and wood supports. The details of methods of construction and anchorage are depicted in the enclosed test drawings

Plastic sheeting (max 6 mil thick) was used to keep the air pressure chamber airtight. The sheeting was placed between the deck and panels. The sheeting was pleated to allow the sheeting to flow into the panel ribs when air pressure was applied to the panels.

2.1.6 SPECIMEN WIDTH & LENGTH

The specimen width was more than ten feet and contained no less than three full panels and five structural elements. Edge seals did not constrain the specimen any more than normal gable attachment. The panels spanned 3 equal spans of 3' 6" and 10 equal spans of 1' 0".

2.1.7 SPECIMEN ORIENTATION AND SEALING

The test specimen was installed in its "as used" orientation, i.e., the interior side of the specimen faced the applied air pressure. The panel was secured to the test jig by the same number and type of fasteners as are normally used for installation of the test specimen on a building. The use of tape or film did not restrict differential movement between adjoining members.

2.1.8 FAILURE

Failure was considered to have occurred when components separated or permanent distortion interfered with the function of the system or the system was unable to carry additional load.

The design load was calculated with factor of safety of 2 as per *AISI 2012 Specifications*.

TEST RESULTS

3.1 SPECIMEN IDENTIFICATION

Panel Manufacturer:	Central States Manufacturing
Model Type:	R-Loc panel
Dimensions:	1.25" high, 36" wide coverage
Panel Thickness (Ga.):	26
Base Metal Thickness:	0.0167" (average)
Panel Yield Stress:	Nom. 80 ksi (105 ksi tested average)
Elongation in 2":	2.3 %
Panel Fasteners:	#10 x1.5" long Kwikseal MB Woodbinder screws with washers (Sealtite Building Fasteners)
Sidelap Fasteners:	1/4"-14 x 7/8" long hex washer head self-drilling screws with bond seal washer (Steelbinder Maxx S-D Sealtite Building Fasteners)
Deck:	Nominal 7/16" thick OSB and 15/32" thick Plywood

Note: All the test materials were supplied by Central States Manufacturing and were not sampled by ENCON.

TEST RESULTS

3.2 TEST RESULTS AT 3' 6" SPAN WITH OSB

Uplift Load Testing of 26 Ga., Central States R-Loc Panel
@ panel span of 3' 6" over 7/16" thick OSB

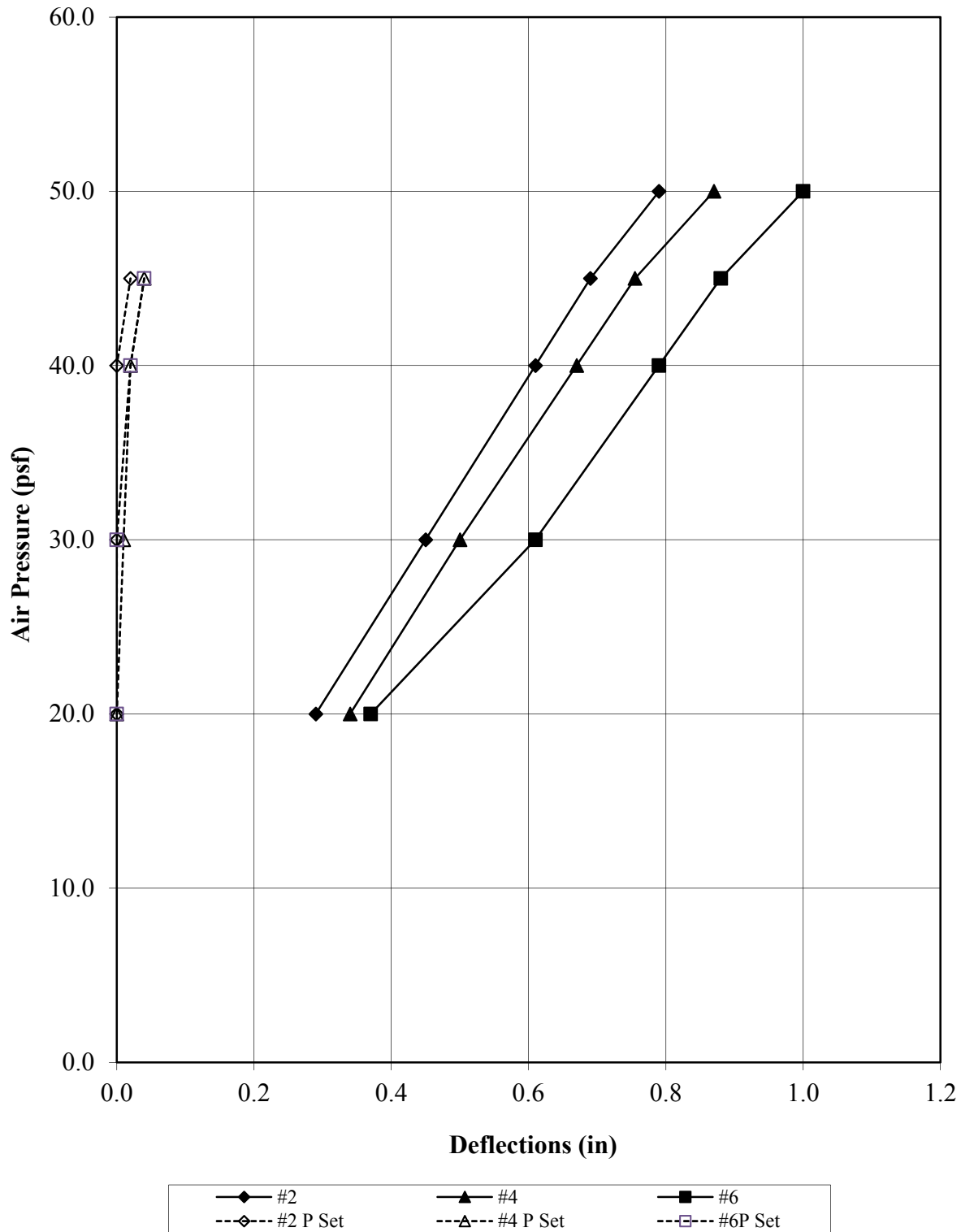
Test #1 conducted on July 26, 2017

No.	Pressure psf	Time Sec	Deflection (in)						Remarks
			1	2	3	4	5	6	
1	20.0	60	0.16	0.29	0.21	0.34	0.24	0.37	
2	5.0		0.01	0.00	0.01	0.00	0.00	0.00	
3	30.0	60	0.24	0.45	0.32	0.50	0.36	0.61	
4	5.0		0.01	0.00	0.02	0.01	0.02	0.00	
5	40.0	60	0.36	0.61	0.45	0.67	0.48	0.79	
6	5.0		0.03	0.00	0.06	0.02	0.05	0.02	
7	45.0	60	0.42	0.69	0.52	0.76	0.54	0.88	
8	5.0		0.05	0.02	0.08	0.04	0.07	0.04	
9	50.0	60	0.50	0.79	0.59	0.87	0.64	1.00	

Failure Mode: Fastener pullout

TEST RESULTS

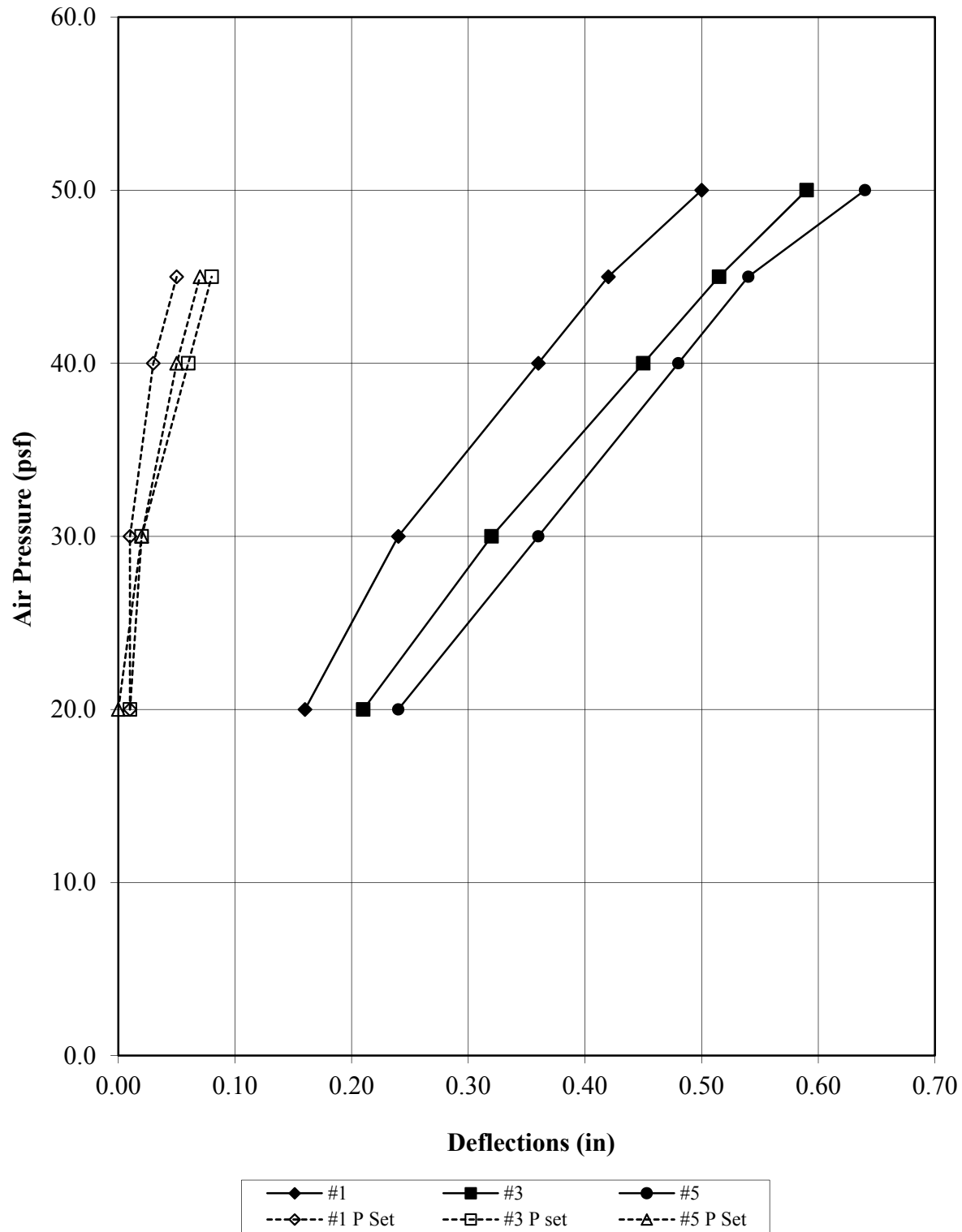
Uplift Load vs Panel Flat Deflections 26 ga. R-Loc Panel at 3' 6" span in OSB (Test #1)



Note: P Set denotes permanent deflection after each load cycle.

TEST RESULTS

Uplift Load vs Panel Rib Deflections 26 ga. R-Loc Panel at 3' 6" span in OSB (Test #1)



Note: P Set denotes permanent deflection after each load cycle.

TEST RESULTS

3.3 TEST RESULTS AT 1' 0" SPAN WITH OSB

Uplift Load Testing of 26 Ga., Central States R-Loc Panel
@ panel span of 1' 0" over 7/16" thick OSB

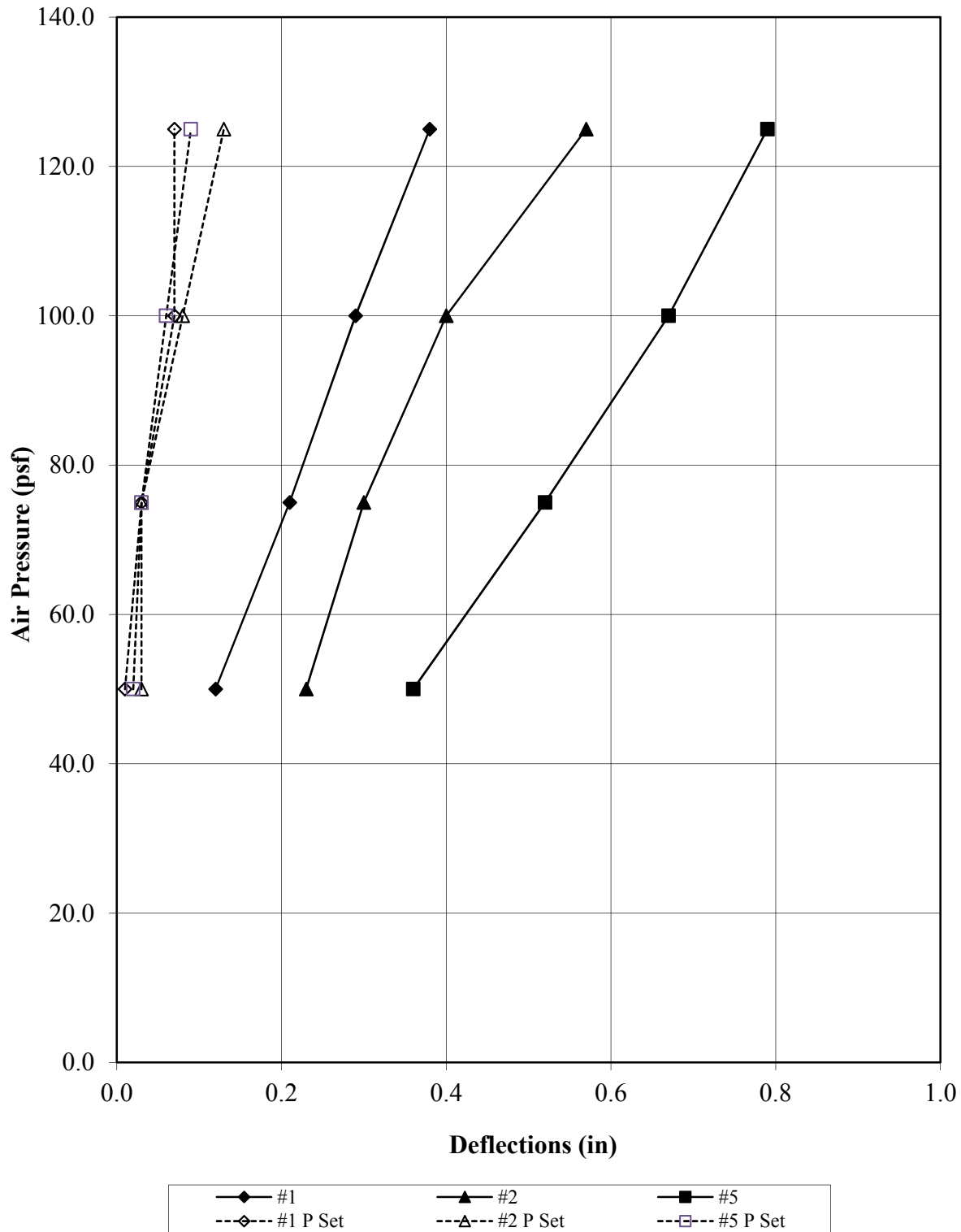
Test #2 conducted on July 27, 2017

No.	Pressure psf	Time Sec	Deflection (in)						Remarks
			1	2	3	4	5	6	
1	50.0	60	0.12	0.23	0.23	0.69	0.36	0.69	
2	5.0		0.01	0.03	0.03	0.03	0.02	0.03	
3	75.0	60	0.21	0.30	0.24	0.92	0.52	0.92	
4	5.0		0.03	0.03	0.06	0.05	0.03	0.05	
5	100.0	60	0.29	0.40	0.48	1.11	0.67	1.11	
6	5.0		0.07	0.08	0.10	0.08	0.06	0.08	
7	125.0	60	0.38	0.57	0.53	1.32	0.79	1.31	
8	5.0		0.07	0.13	0.14	0.11	0.09	0.11	
9	148.0	0							

Failure Mode: Fastener pullout

TEST RESULTS

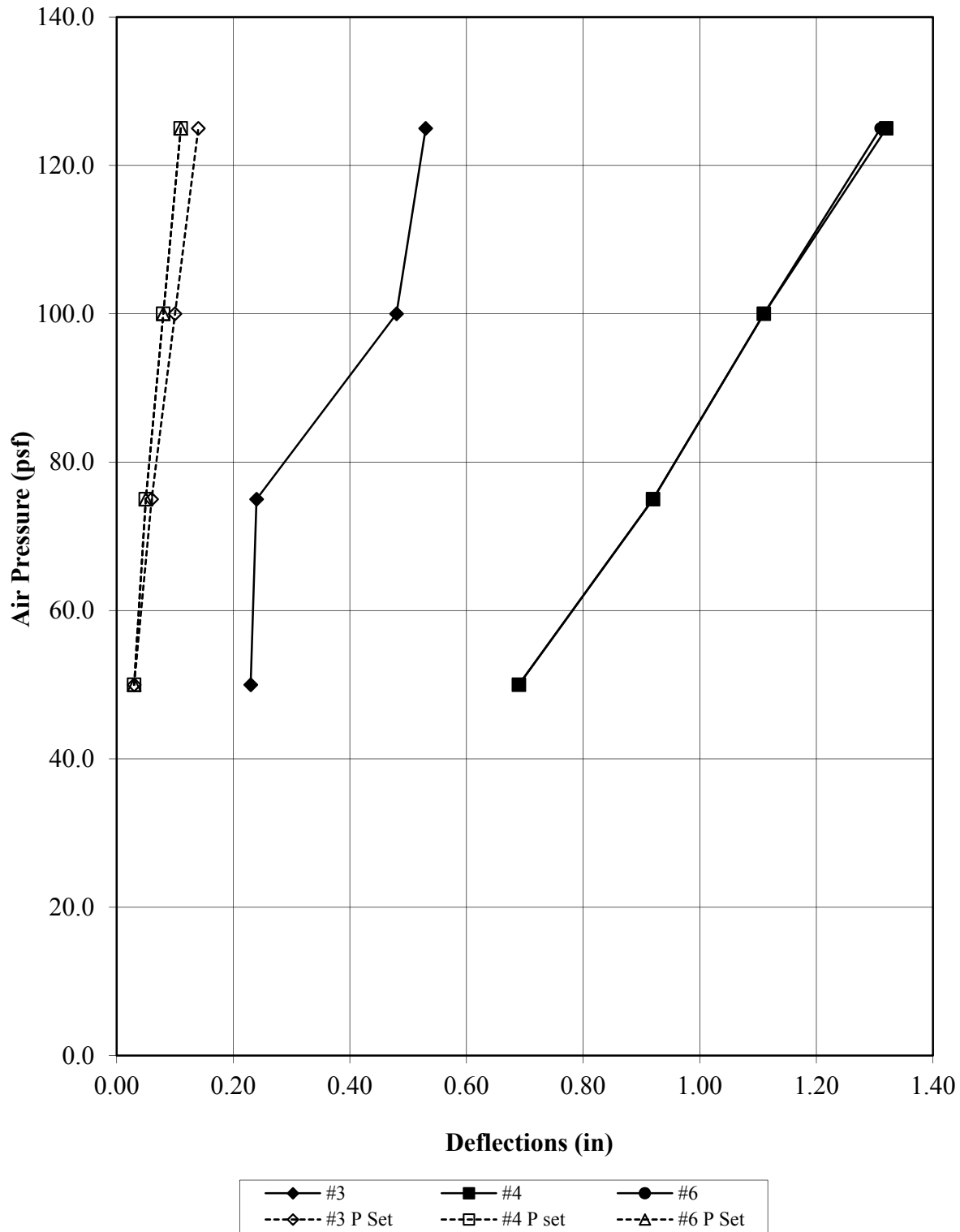
Uplift Load vs Panel Flat Deflections 26 ga. R-Loc Panel at 1' 0" span in OSB (Test #2)



Note: P Set denotes permanent deflection after each load cycle.

TEST RESULTS

Uplift Load vs Panel Rib Deflections 26 ga. R-Loc Panel at 1' 0" span in OSB (Test #2)



Note: P Set denotes permanent deflection after each load cycle.

TEST RESULTS

3.4 TEST RESULTS AT 1' 0" SPAN WITH PLYWOOD

Uplift Load Testing of 26 Ga., Central States R-Loc Panel
@ panel span of 1' 0" over 15/32" thick Plywood

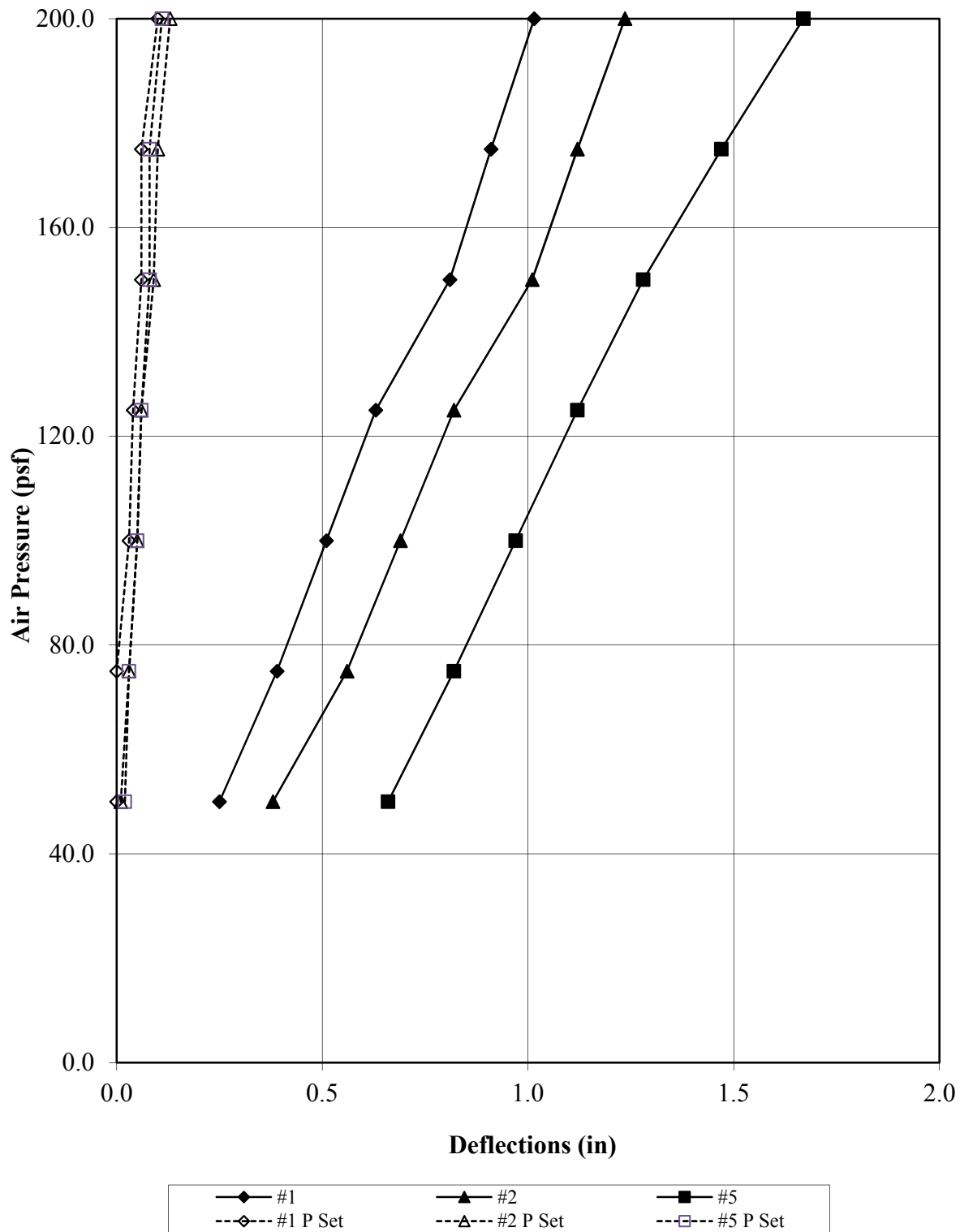
Test #3 conducted on August 2, 2017

No.	Pressure psf	Time Sec	Deflection (in)						Remarks
			1	2	3	4	5	6	
1	50.0	60	0.25	0.38	0.21	0.32	0.66	0.18	
2	5.0		0.00	0.01	0.03	0.05	0.02	0.04	
3	75.0	60	0.39	0.56	0.31	0.44	0.82	0.27	
4	5.0		0.00	0.03	0.05	0.06	0.03	0.07	
5	100.0	60	0.51	0.69	0.41	0.53	0.97	0.33	
6	5.0		0.03	0.05	0.07	0.07	0.05	0.08	
7	125.0	60	0.63	0.82	0.48	0.62	1.12	0.39	
8	5.0		0.04	0.06	0.08	0.09	0.06	0.09	
9	150.0	60	0.81	1.01	0.58	0.72	1.28	0.48	
10	5.0		0.06	0.09	0.10	0.11	0.08	0.13	
11	175.0	60	0.91	1.12	0.70	0.83	1.47	0.60	
12	5.0		0.06	0.10	0.10	0.12	0.08	0.13	
13	200.0	60	1.02	1.24	0.83	0.95	1.67	0.73	
14	5.0		0.10	0.13	0.12	0.14	0.11	0.15	
15	211.0	0							

Failure Mode: Fastener pullout

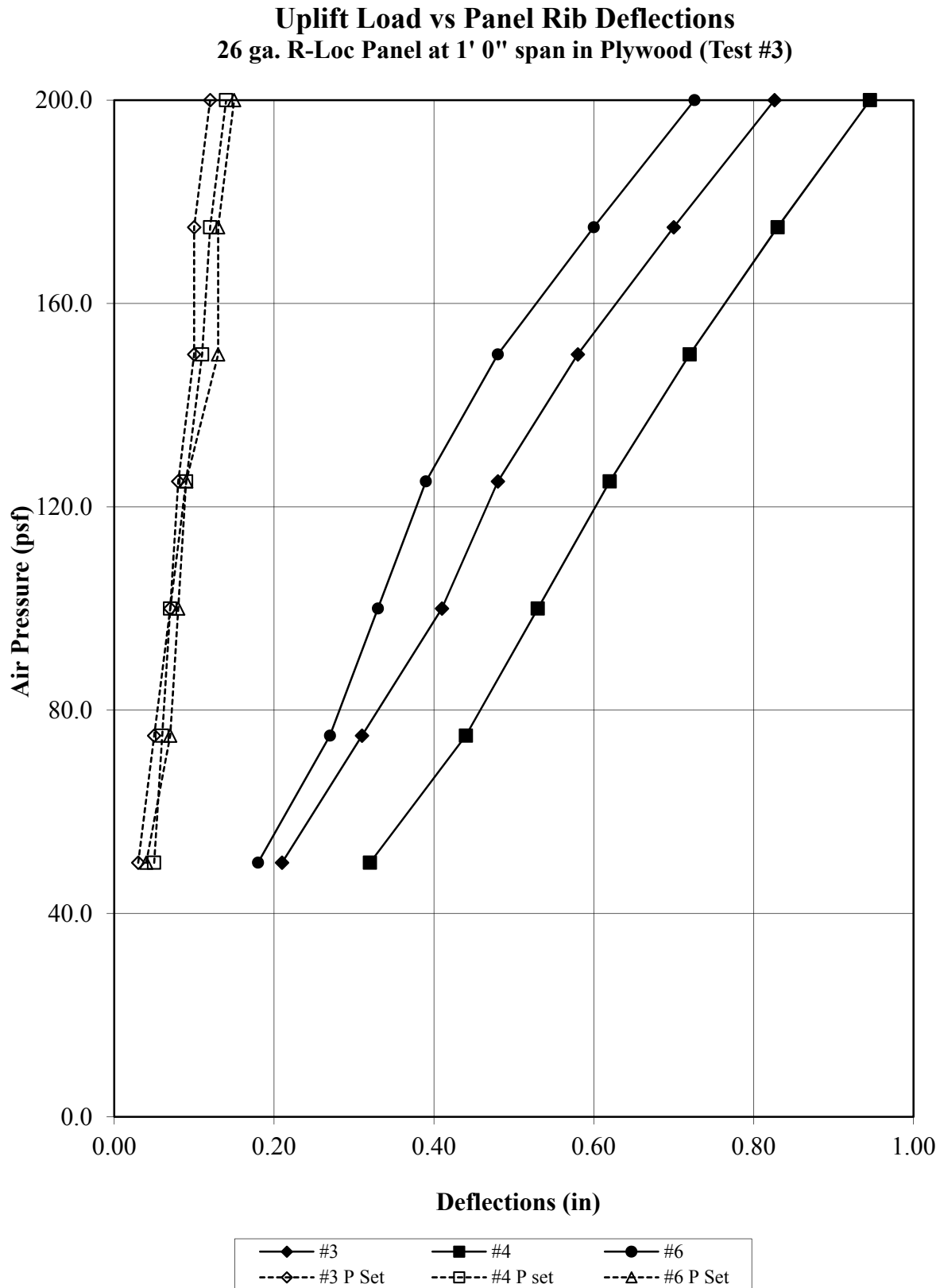
TEST RESULTS

Uplift Load vs Panel Flat Deflections 26 ga. R-Loc Panel at 1' 0" span in Plywood (Test #3)



Note: P Set denotes permanent deflection after each load cycle.

TEST RESULTS



Note: P Set denotes permanent deflection after each load cycle.

PHOTOGRAPHS



PHOTO 1 View of OSB or plywood deck with felt.
(DSCN6734)



PHOTO 2 View of 26 ga. R-Loc panel fastening at panel ends and interior (Test #1).
(DSCN6736)

PHOTOGRAPHS



PHOTO 3 View of Test #1 at pressure of 30 psf.
(DSCN6741)



PHOTO 4 View of Test #1 at pressure of 50 psf.
(DSCN6743)

PHOTOGRAPHS



PHOTO 5 View of Test #1 at failure. The failure mode was the panel fastener pullout. (DSCN6744)

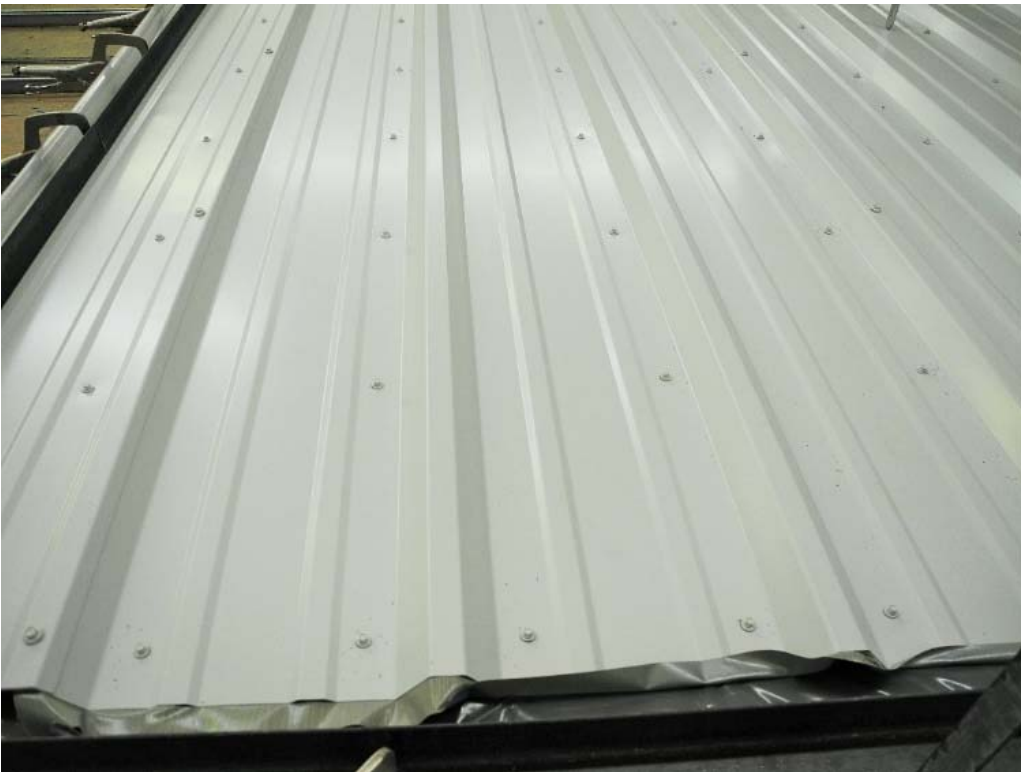


PHOTO 6 View of 26 ga. R-Loc panel fastening at panel ends and interior (Test #2 & 3). (DSCN6745)

PHOTOGRAPHS



PHOTO 7 View of Test #2 at pressure of 75 psf.
(DSCN6748)



PHOTO 8 View of Test #2 at pressure of 125 psf.
(DSCN6750)

PHOTOGRAPHS



PHOTO 9 View of Test #2 at failure. The failure mode was the panel fastener pullout. (DSC00162)

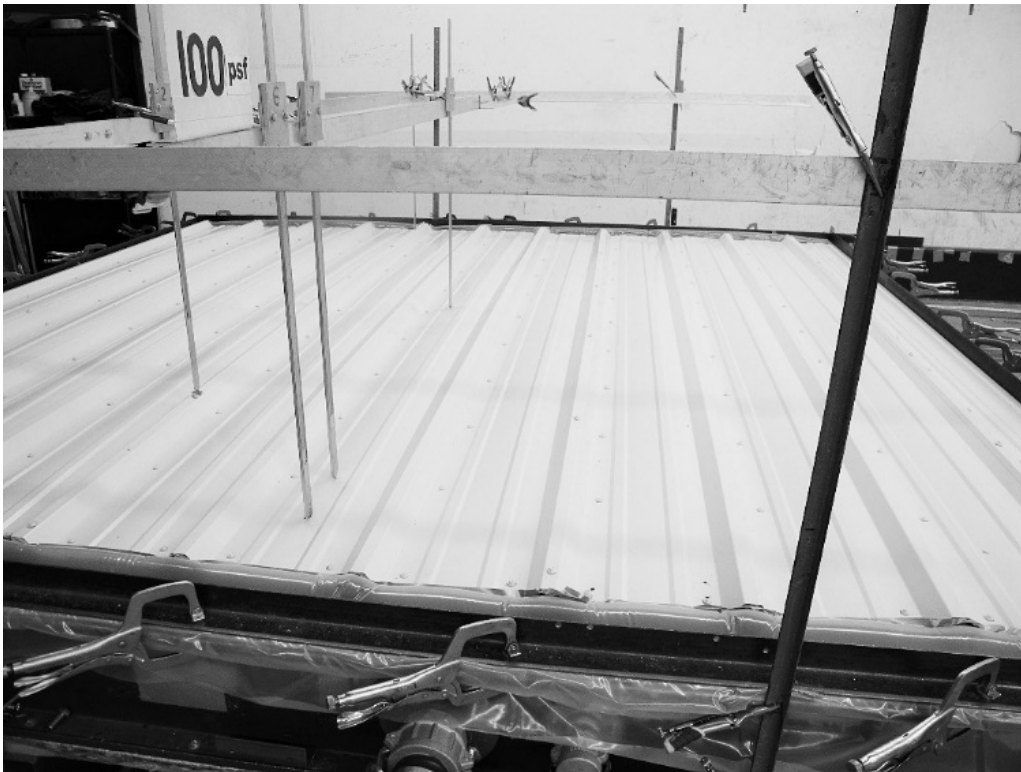


PHOTO 10 View of Test #3 at pressure of 100 psf. (DSCN6758)

PHOTOGRAPHS



PHOTO 11 View of Test #3 at pressure of 175 psf.
(DSCN6761)

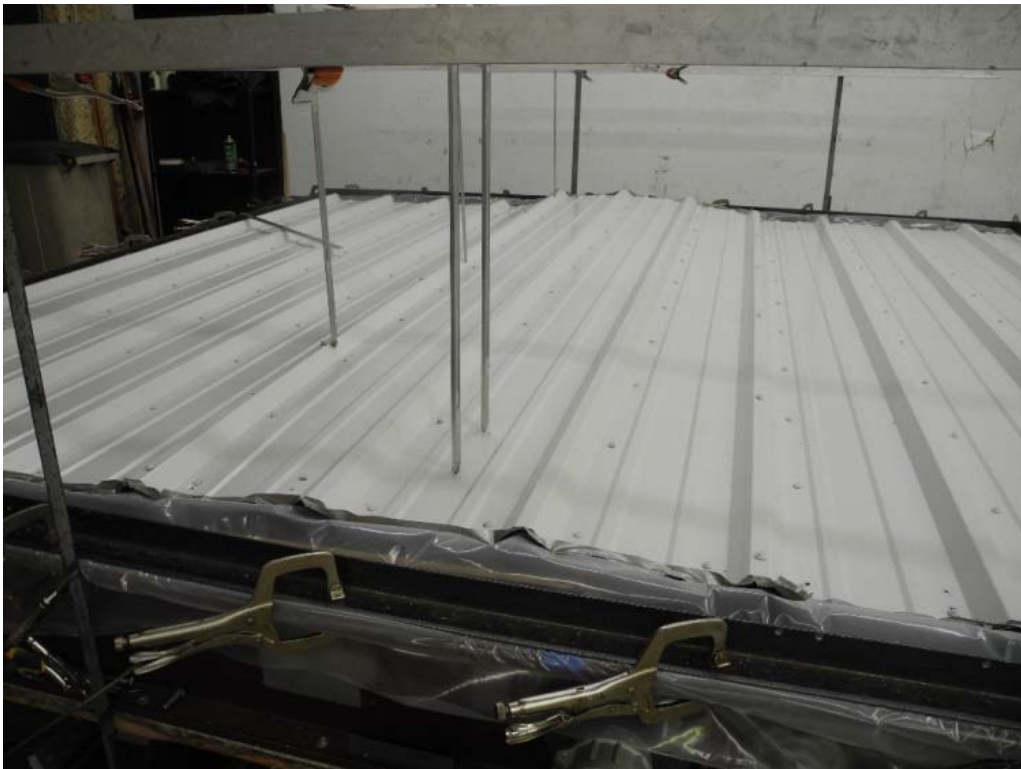
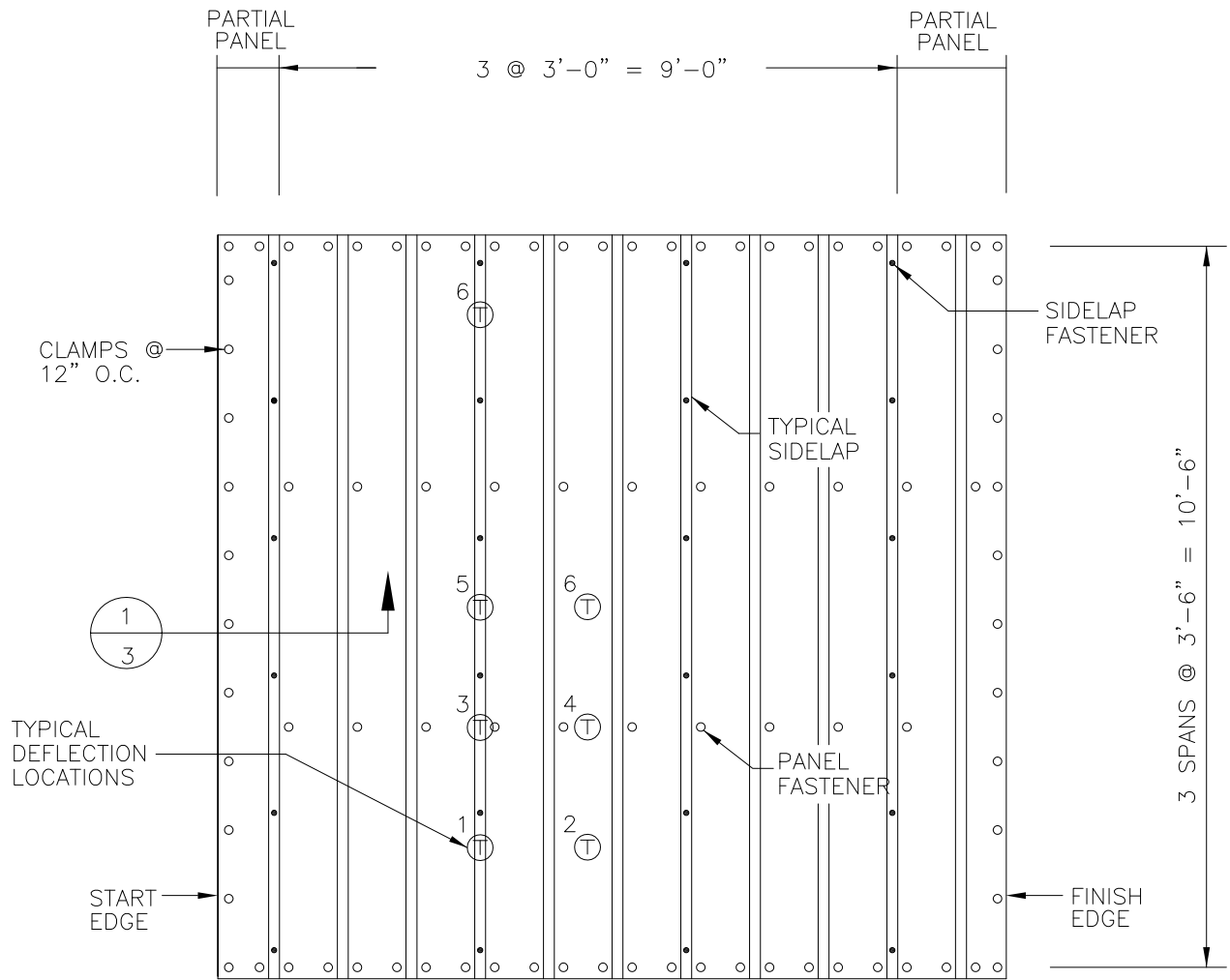
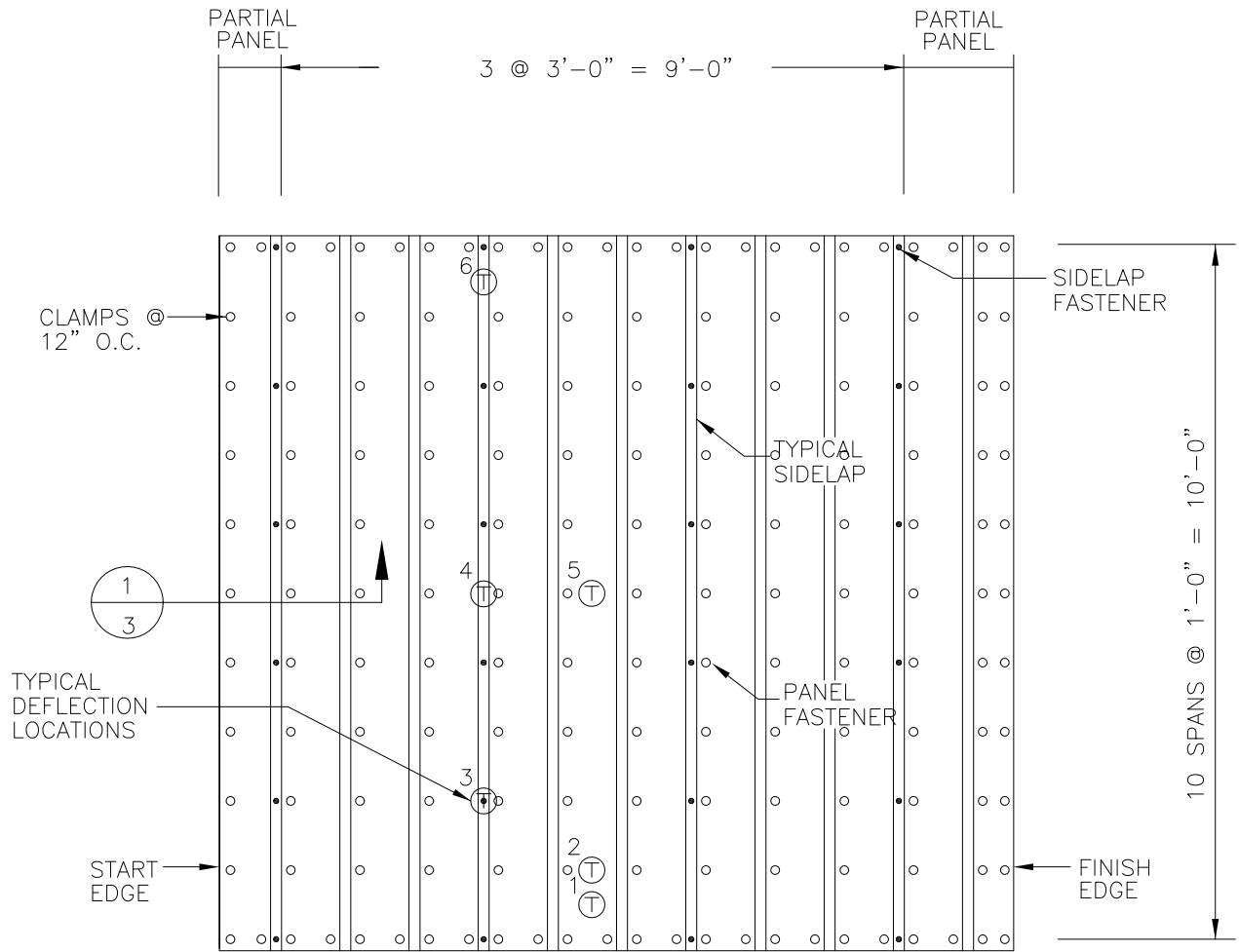


PHOTO 12 View of Test #3 at failure. The failure mode was the panel fastener pullout.
(DSCN6762)

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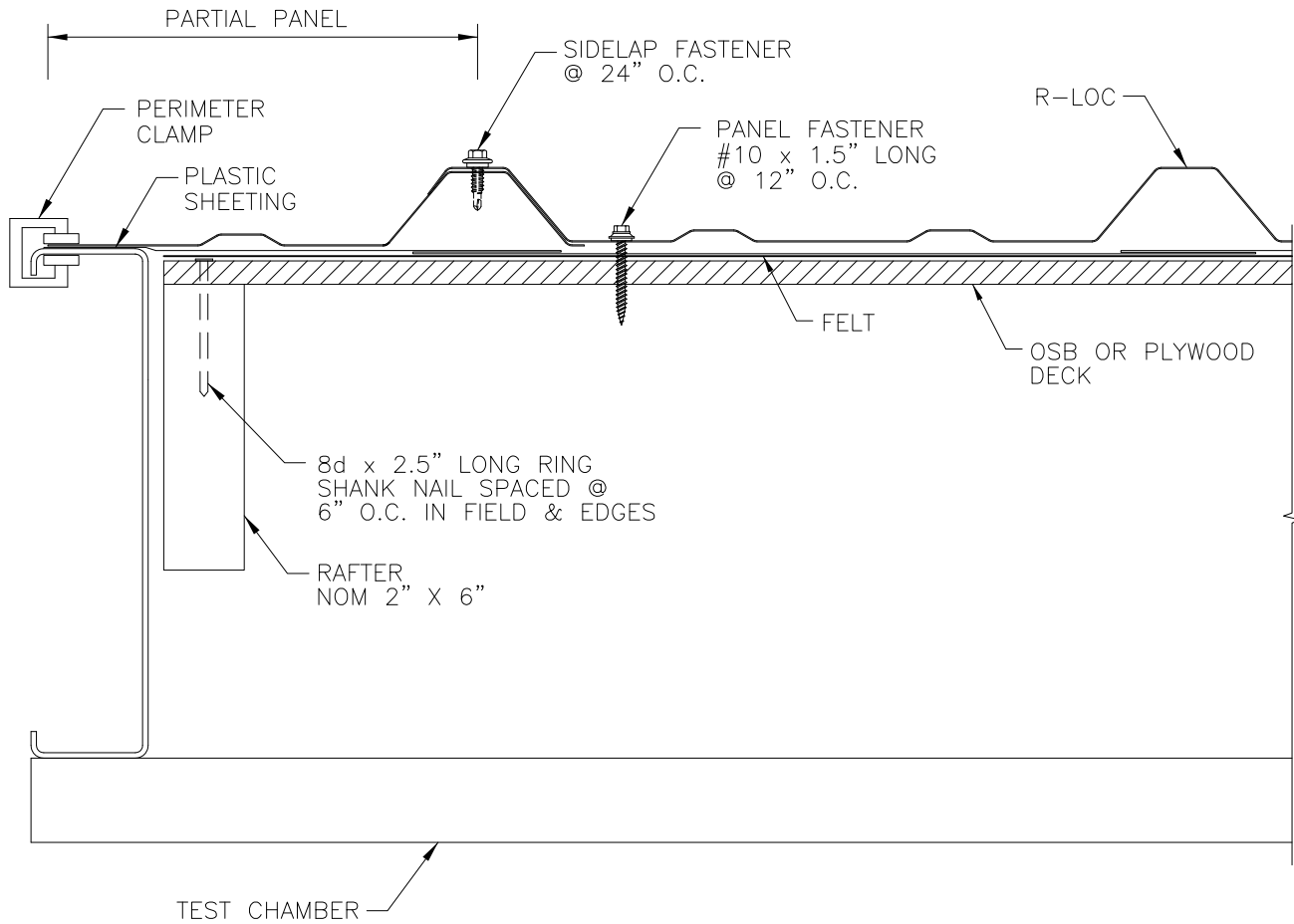


1 PLAN VIEW OF TEST #1
1 3' 6" PANEL SPAN



1 PLAN VIEW OF TEST #2 & #3
2 1' 0" PANEL SPAN

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1
3

DETAIL OF "START EDGE" OF TEST



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Laboratory Report - EAR-Controlled Data

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Report No: B17070699
Date Reported: 7/28/2017
P.O. No: Verbal - bala

Material: Steel

Description: (2) Test Strips, Central States RLoc, Material: Steel

Room Temperature Tensile Testing ASTM E8/E8M-16a, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, ksi	Yield (0.2% Offset), ksi	Elongation After Fracture (in 2 inches), %	Location of Fracture
Sample 1	0.506	0.0166	108	104	2.0	Inside Middle Third of Gage

Room Temperature Tensile Testing ASTM E8/E8M-16a, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, ksi	Yield (0.2% Offset), ksi	Elongation After Fracture (in 2 inches), %	Location of Fracture
Sample 2	0.506	0.0167	108	105	2.6	Inside Middle Half of Gage

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Approved by:

Doug Kookan
Operations Manager

APPENDIX

5.3 TEST CONDITIONS

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ENCON will use its normal procedures to retain copies of the information developed as a part of this test for a period of three years from the date the work was done. This material may be routinely destroyed thereafter.

B. ENCON GUARANTEE

ENCON guarantees it used its best effort to accomplish this test work. Work done by ENCON was carefully completed by personnel believed to be competent. ENCON tests were based on what was currently believed to be good engineering practices in use at the time of the test.

The safety factors used are generally accepted as suitable to produce safe results. However, good engineering practices and applicable codes and insurance requirements must be taken into consideration in determining if a test procedure is satisfactory for a specific end use. Applicable specifications, good engineering practices and applicable safety factors may change in the future. CUSTOMER should be alert to these changes.

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If any doubt exists as to the proper means of interpreting or using the test results contained herein, contact ENCON for clarification. CUSTOMER should assure themselves through careful evaluations that test results are suitable for those end uses to which CUSTOMER intends to put them.

APPENDIX

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