TEST REPORT ON

CENTRAL STATES MANUFACTURING, INC.'S R-LOC PANELS (26 GA., 80 KSI, 36" WIDE) FASTENED TO WOOD SUPPORTS AT 2' 0" PANEL SPANS IN ACCORDANCE WITH ASTM E455-11 AND AISI S907-08

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TESTING DATE: December 13, 2012
REPORTING DATE: December 20, 2012
ENCON® Project C1872-1

ACCREDITED
TL-327

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TEST SUMMARY

1.1 SUMMARY

Tests were conducted on Central States Manufacturing, Inc.'s 26 ga., 80 ksi R-Loc Panels at ENCON® Technology, Inc.'s Test Facility, Tulsa, Oklahoma. The purpose of the tests was to determine the diaphragm shear strength and shear stiffness of R-Loc panel construction under simulated loading conditions. These tests meet the provisions of ASTM E455-11 and AISI S907-08. The tests are listed below according to date tested.

Test #1 & 2: R-Loc panels at four equal spans of 2' 0". The structural fastener spacing was 12" o.c. at the end and interior wood supports. Both tests were conducted on December 13, 2012.

The sidelap fasteners spacing for both tests was 20" o.c. The above-defined tests were witnessed by Bala Sockalingam, Ph.D., P.E. of ENCON Technology, Inc.

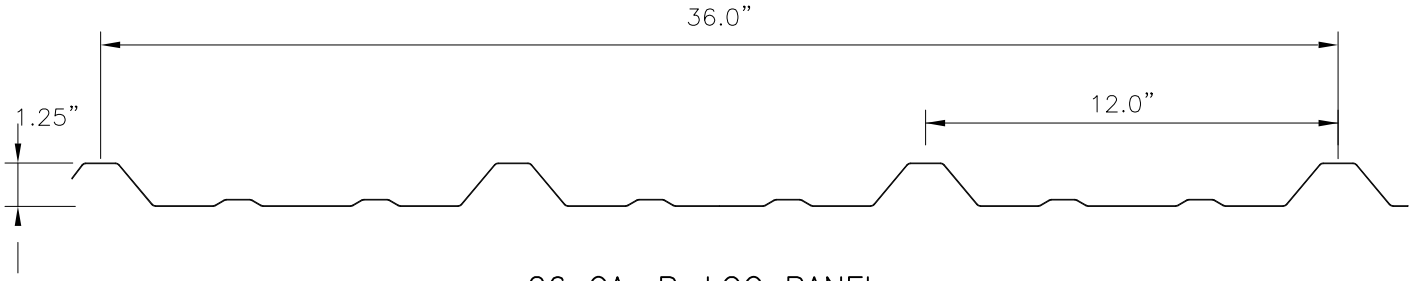
1.2 PANEL SYSTEM DESCRIPTION

Central States Mfg.'s R-Loc panels were 26 ga., 1-1/4" high and 36" wide through fastened panels. Each panel consisted of four major ribs spaced at 12" o.c. as shown on Page 2.

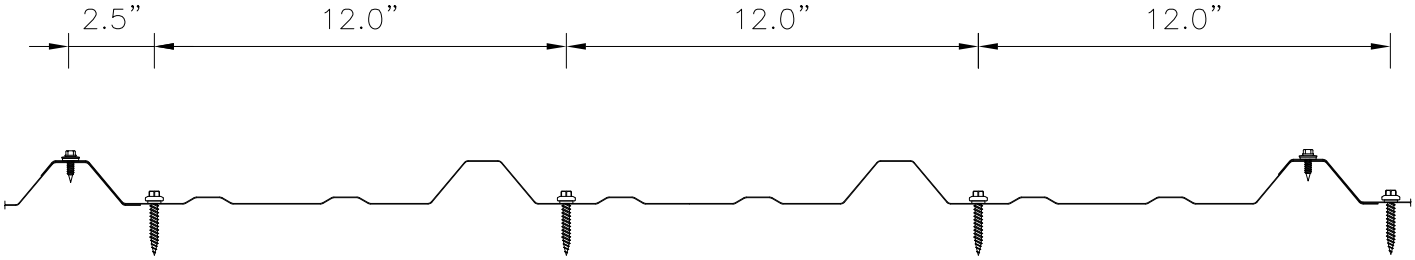
The panels were fastened to nominal 2" x 6" SPF wood supports with #10 x 1-1/2" long Kwikseal® II Wood Binder screws with washers. The screw spacing was 12" o.c. at the end and interior wood supports. Each panel spanned over four continuous spans of 2' 0" with 2" overhang. The sidelap fasteners were #12 x 3/4" long hex head stitch screws with washers and spaced at 20" o.c. The two sides of the panel assembly were not attached to the side post of the interior frame.

1.3 TEST RESULTS

Load was applied incrementally and deflections of the test construction were recorded for 'no load' condition and at each load increment. The failure mode in both tests was the panel slotting at fastener location near the roller corner. The average ultimate shear strength from the two test constructions was 302.1 lb/ft and average shear stiffness was 6733.6 lb/in.



26 GA. R–LOC PANEL



a. AT END & INTERMEDIATE SUPPORTS

TEST SERIES	PANEL SPANS (ft)	SPAN a (ft)	DEPTH b (ft)	MAX. LOAD Pu (lb)	SHEAR STRENGTH Su (lb/ft)	0.4Pu (lb)	DEFL. AT 0.4Pu (in)	SHEAR STIFFNESS G’ (lb/in)
1	2–2–2–2	8.33	12.0	3500	291.7	1400	0.150	6478.9
2	2–2–2–2	8.33	12.0	3750	312.5	1500	0.149	6988.3
				AVERAGE	302.1		AVERAGE	6733.6

NOTES:

1. PANEL THICKNESS WAS 26 GA. AND YIELD STRESS WAS 80 KSI (NOM.).
2. PANEL TO SUPPORT FASTENER WAS #10 X 1.5” LONG WOOD SCREW.
3. PANEL TO PANEL FASTENER WAS #12 X 3/4” LONG STITCH SCREW.
4. PANEL TO PANEL FASTENER SPACING WAS 20” OC.

2.1 DESCRIPTION OF TEST

OBJECTIVES

Tests were conducted to determine shear strength and shear stiffness of the panels under simulated loading conditions. The test method consisted of the following:

1. assembling the test panel on an interior test frame to form a typical roof or wall construction;
2. loading the test frame incrementally; and
3. observing, measuring, and recording the deflections, deformations, and nature of any failures of principal or critical elements of the test construction.

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.

TEST SETUP

The test setup consisted of an exterior reaction truss and interior panel support frame as shown in the applicable drawings in the appendix. The L-shaped reaction truss was constructed of two built-up tube sections with cross-braced angle sections to form a truss. The panel support frame was constructed of wood supports having equal or lower strength and stiffness than that intended for use in the typical constructions. All the connections in the interior frame were pinned.

Both the truss and frame lay in the same horizontal plane. The reaction frame was supported by short columns, which rested on the laboratory floor. Two corners of the interior frame were connected to the exterior frame with a hinge and roller. The side opposite to these corners was held up by columns with roller bases. The interior supports were attached to the side post with pinned connections.

LOADING DEVICE

Load was applied using a 10 kip capacity hydraulic ram and manual pump. The load was monitored with a calibrated 10 kip capacity load cell and associated instrumentation. The accuracy of the load cell was estimated to be $\pm$ 0.01 kips. The hydraulic ram was attached to the reaction truss and the load cell was attached to the interior frame. The load was applied parallel to and in close proximity to one of the points of contact between the diaphragm web and frame.

DEFLECTION MEASUREMENT

Deflection measurements were taken by means of dial indicators calibrated to 1/1000 of an inch. Deflections were measured at locations as shown on the drawings in the appendix. The deflection locations are based on AISI S907-08.

DESCRIPTION OF TEST

DIAPHRAGM SIZE

The overall dimension of each construction was in excess of 12' x 8' 4". The panels covered four equal spans of 2' 0". The construction width contained four full panels. The panels were attached to the end and interior wood supports with self-drilling screws. The panels were not attached to the side member of the interior frame. The details of the methods of construction are depicted in the enclosed test drawings. All the material used in the construction represented a typical construction.

NUMBER OF TESTS

Minimum of two panel assemblies was tested to determine the value of a given construction.

TEST PROCEDURE

Prior to the diaphragm construction, the interior frame was loaded to determine its bare frame stiffness. The bare frame stiffness was insignificant, deflecting 1" under a 10-lb load. The loading procedure on the completed diaphragm construction consisted of loads applied in increments. The diaphragm was loaded to 20% of the anticipated ultimate load and unloaded. Deflection measurements were recorded at 'no load' conditions. The diaphragm was loaded in 250-lb increments until failure. Deflection measurements were recorded at every load increment.

TEST DURATION

The test was stopped when the test specimen was unable to carry additional load or visual failure of one or more components of the diaphragm occurred.

2.2 CALCULATIONS

The ultimate shear strength S_u (lb/ft) of a given construction is
where

$$S_u = \frac{P_u}{b}$$

P_u = maximum applied load in the cantilever beam test (lb),
b = depth of diaphragm (ft).

The net shear deflections (Δ) at any load level in the cantilever beam test is

$$\Delta = \Delta_3 - \left[\Delta_2 + \frac{a}{b}(\Delta_1 + \Delta_4) \right]$$

where Δ_1, Δ_2, Δ_3 and Δ_4 are measured deformations with appropriate signs at locations shown in the test drawings.

DESCRIPTION OF TEST

The apparent shear stiffness G' (lb/in) of a given construction is where

$$G' = \frac{P}{\Delta}\left(\frac{a}{b}\right)$$

P = $0.4P_u$ in the cantilever beam test (lb),
a = span of diaphragm (ft).
Δ = Net shear deflection of diaphragm (in) at $0.4P_u$ load.

The shear stiffness calculation is based on AISI S907-08.

TEST RESULTS

3.1 SPECIMEN IDENTIFICATION

Manufacturer:	Central States Manufacturing, Inc
Model Type:	R-Loc Panel
Dimensions:	1.25" high, 36" wide coverage
Panel Thickness:	26 ga.
Base Metal Thickness:	0.017"
Panel Yield Stress:	Nom. 80 ksi (Tested tensile strength 106.4 ksi)
Panel Fasteners:	#10 x 1.5" long hex head wood screws with washers (Sealtite Building Fasteners Kwikseal® II Wood Binder)
Panel Fasteners Spacing:	12" o.c.
Support Thickness:	Nom. 2" x 6" SPF
Sidelap Fasteners:	#12 x 3/4" long hex head stitch screws with washers (Sealtite Building Fasteners)
Sidelap Fasteners Spacing:	20" o.c.

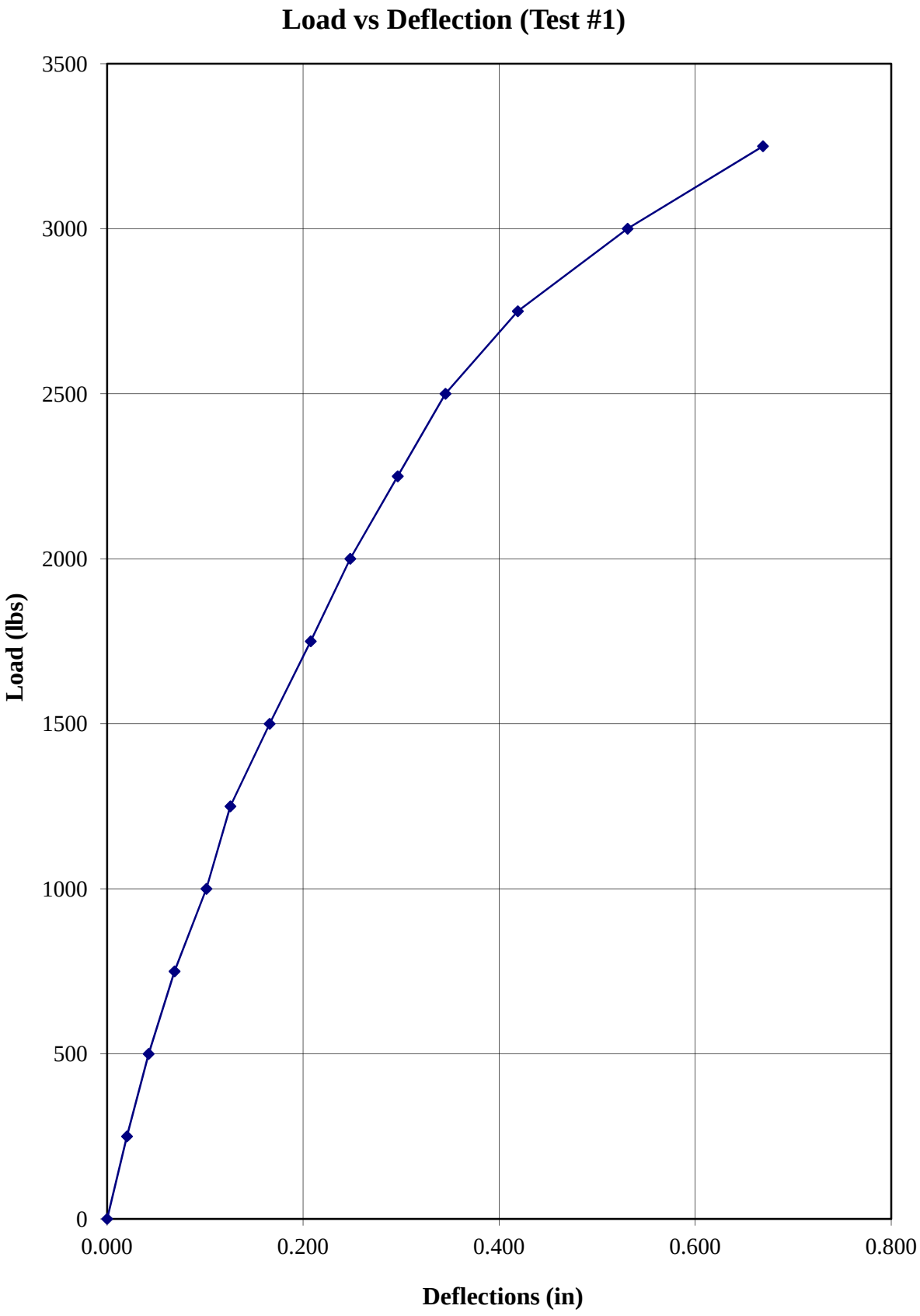
Note: All the test materials were supplied by or purchased for Central States Manufacturing and were not sampled by ENCON.

3.2 TEST #1: 26 GA. R-LOC AT FOUR EQUAL SPAN OF 2' 0"

Date:	12.13.12
Panel Type:	R-Loc
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	4 spans @ 24" o.c.
Type of Structural Fastener:	#10x1.5" long Kwikseal II screws
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Interior Supports:	12" o.c.
Insulation	None
Type of Sidelap Fastener:	#12 x 3/4" long stitch screws
Sidelap Fastener Spacing	20" o.c
a = span length of diaphragm (ft):	8.33
b = depth of diaphragm (ft):	12.00

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
250	0.008	0.014	0.078	0.055	0.020
500	0.015	0.032	0.166	0.117	0.042
750	0.021	0.039	0.239	0.168	0.069
1000	0.036	0.051	0.330	0.220	0.101
1250	0.040	0.118	0.459	0.270	0.126
1500	0.028	0.141	0.547	0.318	0.166
1750	0.021	0.145	0.620	0.364	0.208
2000	0.021	0.160	0.701	0.401	0.248
2250	0.021	0.170	0.799	0.458	0.296
2500	0.021	0.179	0.881	0.493	0.345
2750	0.022	0.180	0.994	0.547	0.419
3000	0.016	0.197	1.189	0.648	0.531
3250	0.011	0.205	1.376	0.712	0.669
3500					

Failure Mode:	Panel slotting at the fastener near roller corner	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	63.5	30
At testing	63.5	30

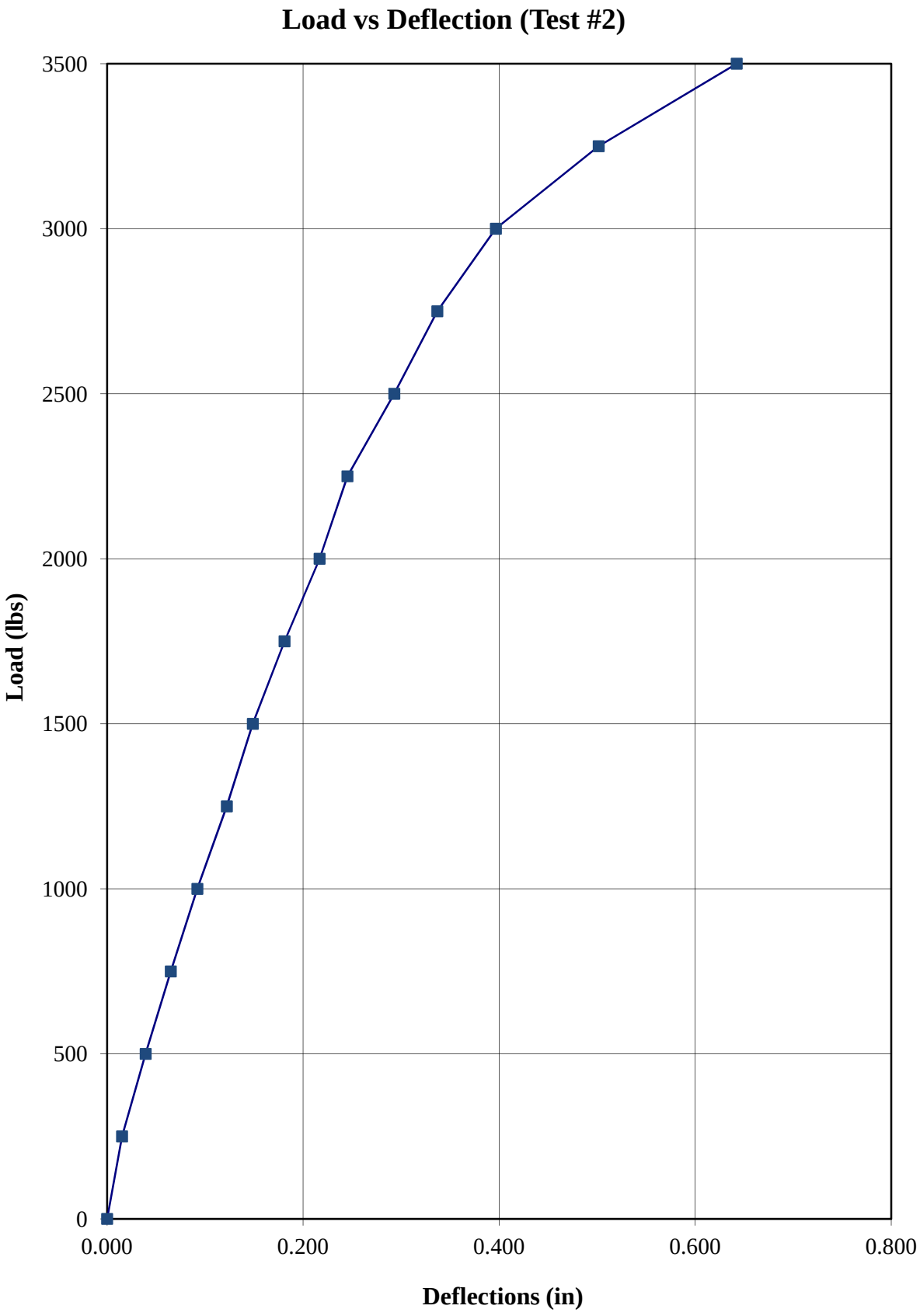

Load vs Deflection (Test #1)
3500
3000
2500
2000
1500
1000
500
0
Load (lbs)
0.000
0.200
0.400
0.600
0.800
Deflections (in)

3.3 TEST #2: 26 GA. R-LOC AT FOUR EQUAL SPAN OF 2' 0"

Date:	12.13.12
Panel Type:	R-Loc
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	4 spans @ 24" o.c.
Type of Structural Fastener:	#10x1.5" long Kwikseal II screws
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Interior Supports:	12" o.c.
Insulation	None
Type of Sidelap Fastener:	#12 x 3/4" long stitch screws
Sidelap Fastener Spacing	20" o.c
a = span length of diaphragm (ft):	8.33
b = depth of diaphragm (ft):	12.00

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
250	0.010	0.016	0.075	0.053	0.015
500	0.017	0.024	0.148	0.105	0.039
750	0.024	0.035	0.218	0.146	0.065
1000	0.029	0.046	0.288	0.187	0.092
1250	0.032	0.058	0.362	0.230	0.122
1500	0.034	0.070	0.438	0.282	0.149
1750	0.036	0.084	0.517	0.327	0.181
2000	0.036	0.096	0.596	0.372	0.217
2250	0.037	0.116	0.693	0.441	0.245
2500	0.037	0.136	0.792	0.486	0.293
2750	0.037	0.158	0.892	0.535	0.337
3000	0.039	0.176	1.012	0.594	0.397
3250	0.040	0.197	1.208	0.694	0.501
3500	0.043	0.217	1.448	0.805	0.642
3750					

Failure Mode:	Panel slotting at the fastener near pinned end.	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	63.5	30
At testing	63.5	30


Load vs Deflection (Test #2)
Load (lbs)
3500
3000
2500
2000
1500
1000
500
0
0.000
0.200
0.400
0.600
0.800
Deflections (in)

PHOTOGRAPHS

PHOTO 1 View of the structural and sidelap fasteners.
(DSCN1011)

PHOTO 2 View of the wood support layout.
(DSCN1040)

PHOTOGRAPHS

PHOTO 3 View of the fasteners at end and interior supports.
(DSCN1003)

PHOTO 4 Overview of the diaphragm test setup of the R-Loc panels.
(DSCN0992)

PHOTOGRAPHS

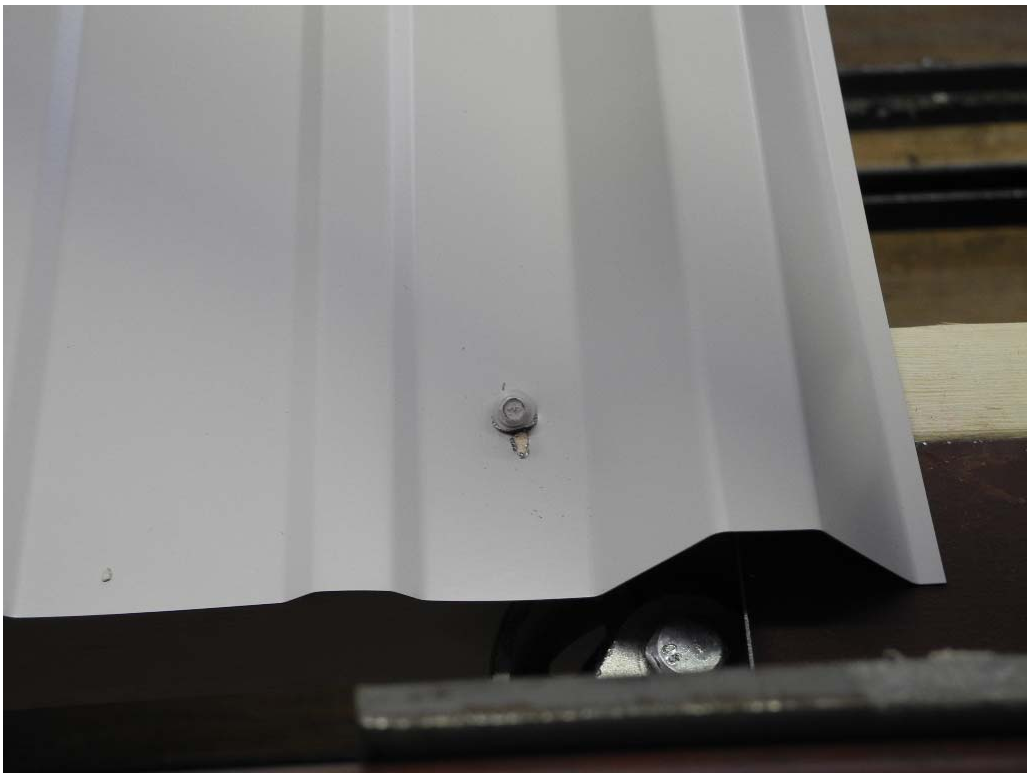
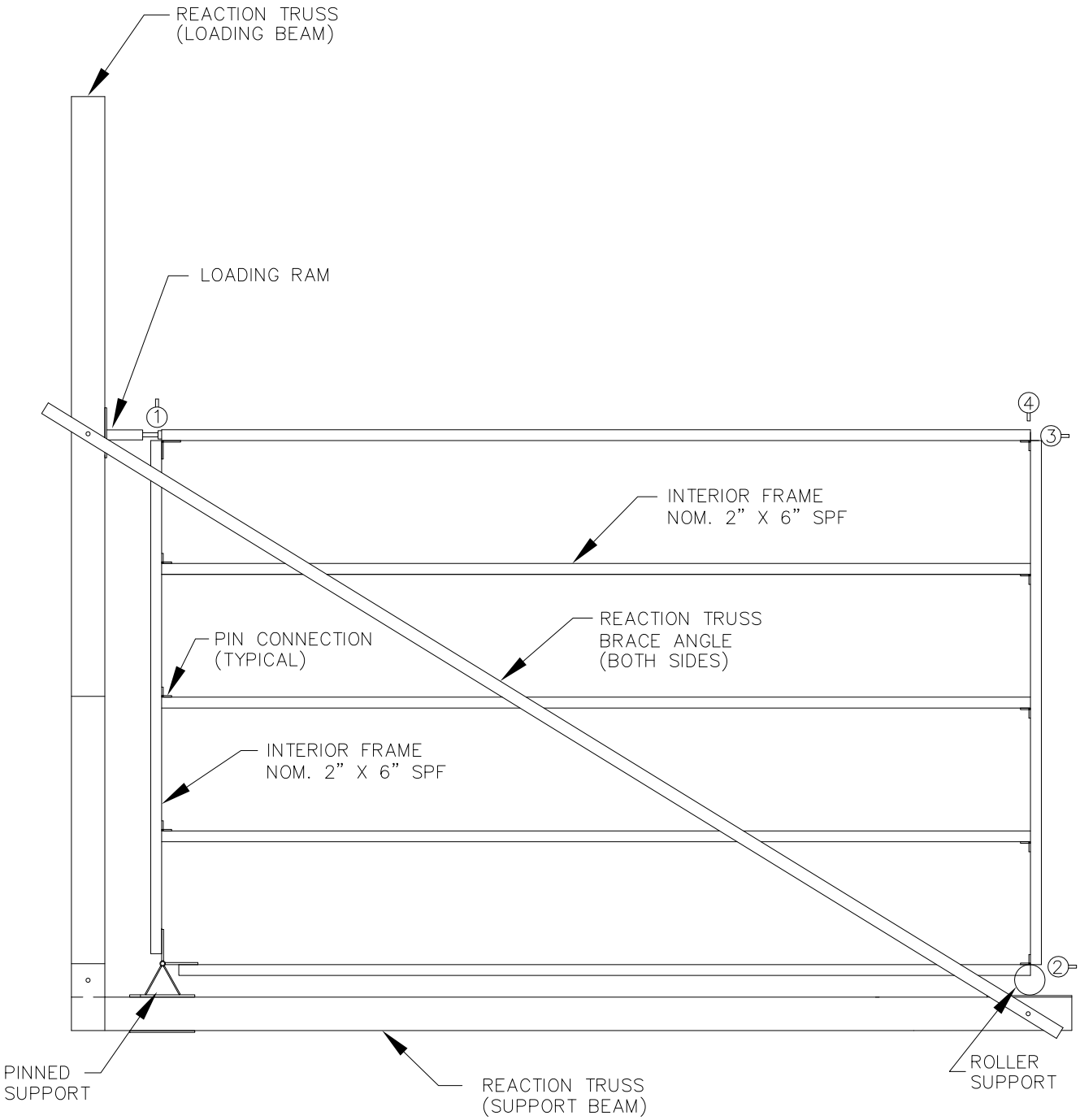


PHOTO 5 View of panel slotting at fastener near the roller support in Test #1. (DSCN0999)

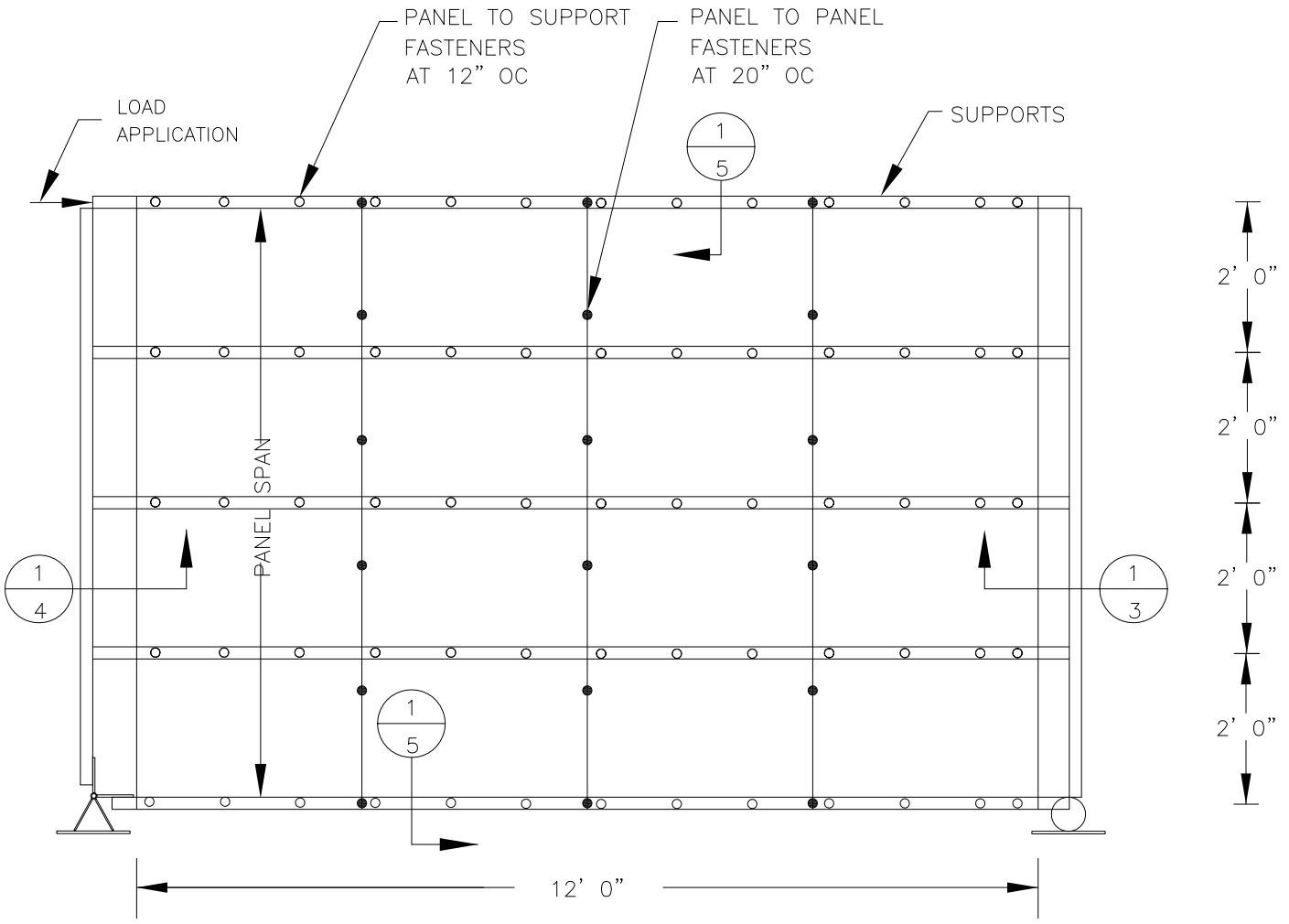
PHOTO 6 View of panel slotting at fastener near the roller support in Test #2. (DSCN1011)



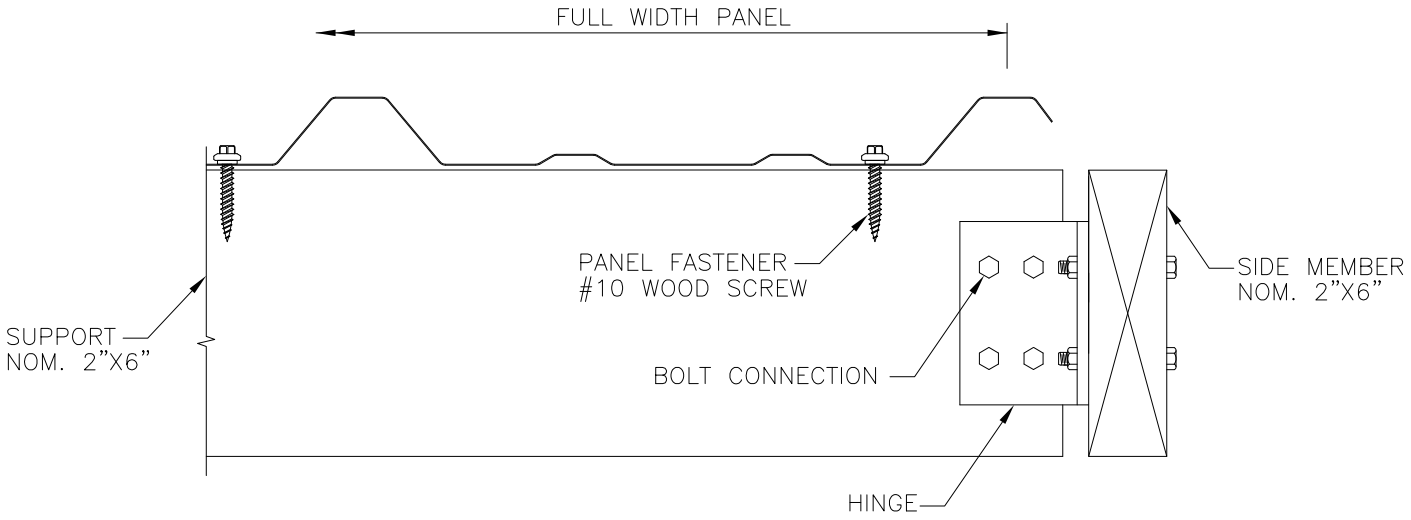
1/1 TEST SETUP PLAN VIEW

NOTES:

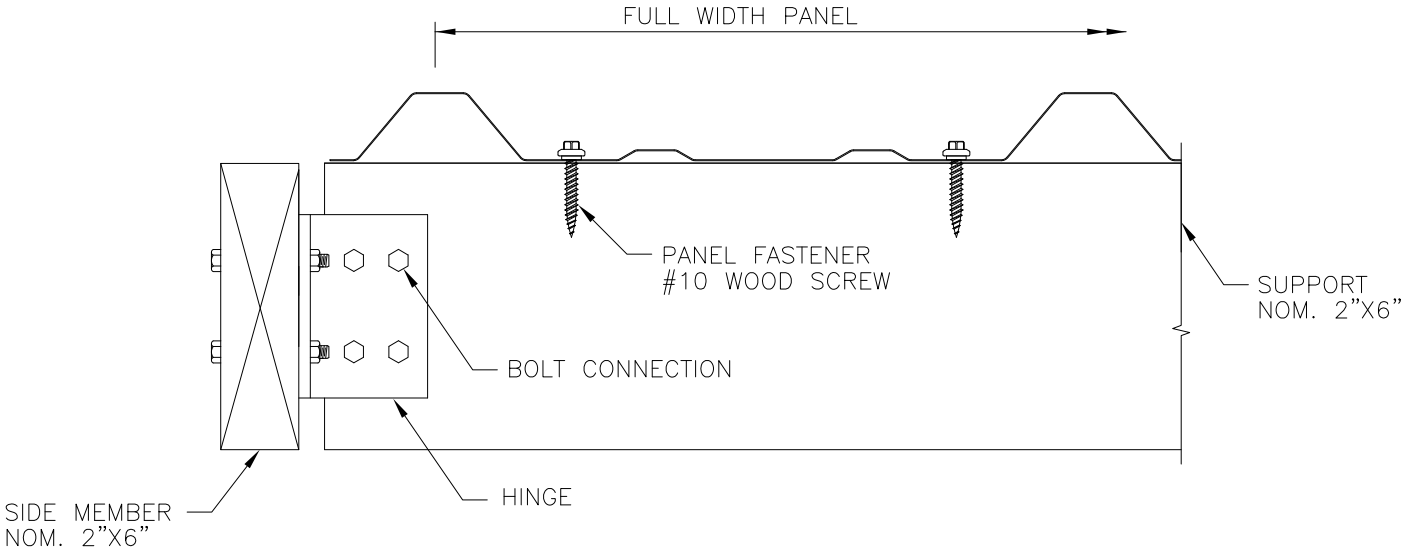
① DIAL INDICATOR LOCATION



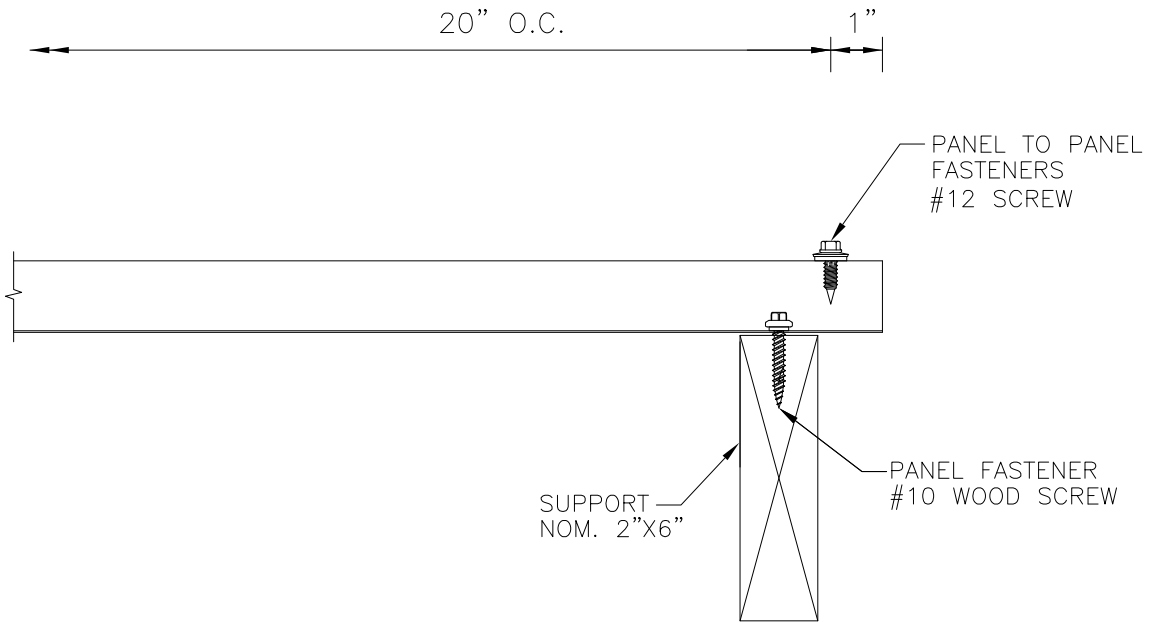
1/2 PLAN VIEW OF TEST PANEL SETUP



1/3 DETAILS OF "STARTER RAKE" OF TEST ROOF



1/4 DETAILS OF "FINISHED RAKE" OF TEST ROOF



1/5 DETAILS OF "END SUPPORTS" OF TEST ROOF

SHERRY LABORATORIES

TESTING TODAY, PROTECTING TOMORROW

WWW.SHERRYLABS.COM

Western Materials, SEG, & Nonmetallics
3100 North Hemlock Circle
Broken Arrow, OK 74012-1115

Tel: 918-258-6066
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Fax: 918-258-1154

LABORATORY REPORT

Attn: **Bala Sockalingam**

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Suite C
Tulsa, OK 74106 United States

Report No: **B12120915**
Date Reported: **12/19/2012**
P.O. No: **Verbal**

Material: **Steel**

Description: **(2) Central State Mfg. Test Samples**

Room Temperature Tensile Testing ASTM E8/E8M-11, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, psi	Yield (0.2% Offset), psi	Elongation (4W), %	Location of Fracture
R-Loc, Sample No.: 13	0.502	0.017	106400		2	Outside Middle Half of Gage

Specimen broke with extensometer.

Room Temperature Tensile Testing ASTM E8/E8M-11, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, psi	Yield (0.2% Offset), psi	Elongation (4W), %	Location of Fracture
Panel-Loc Plus, Sample No.: 14	0.504	0.018	95600	94500	4	Inside Middle Half of Gage

Approved by:

Jason Pierce
Materials Testing Supervisor

APPENDIX

5.3 TEST CONDITIONS

A. OWNERSHIP OF ENCON WORK PRODUCT

All test results developed as a part of this work shall be CUSTOMER's property. All samples submitted to ENCON for testing shall become the property of ENCON. CUSTOMER understands that any test program including procedures and test machines incorporated as a part of this work is a result of continuing long-term research and development by ENCON and because of this all ENCON test procedures, test drawings and other intellectual property relating to this work is and shall remain the property of ENCON. Test samples were disposed of shortly after completion of the tests unless other arrangements were agreed to in writing prior to the test.

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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